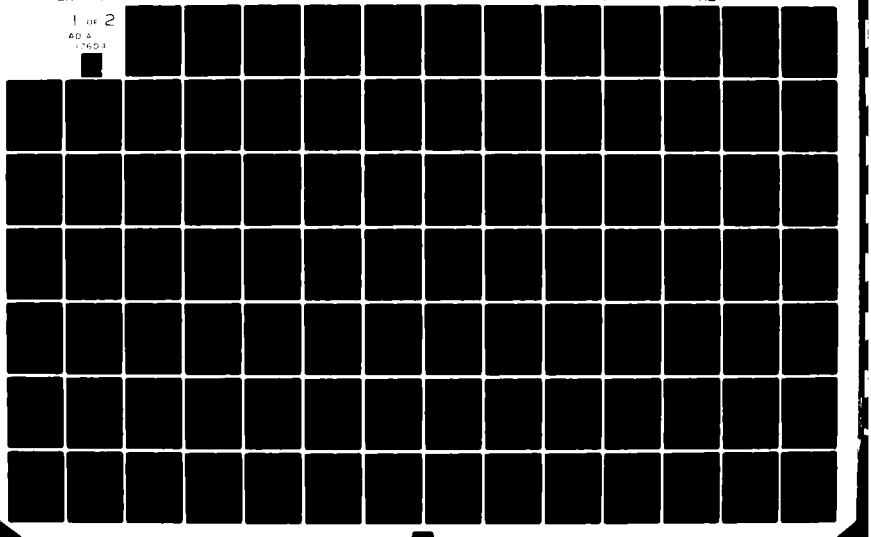
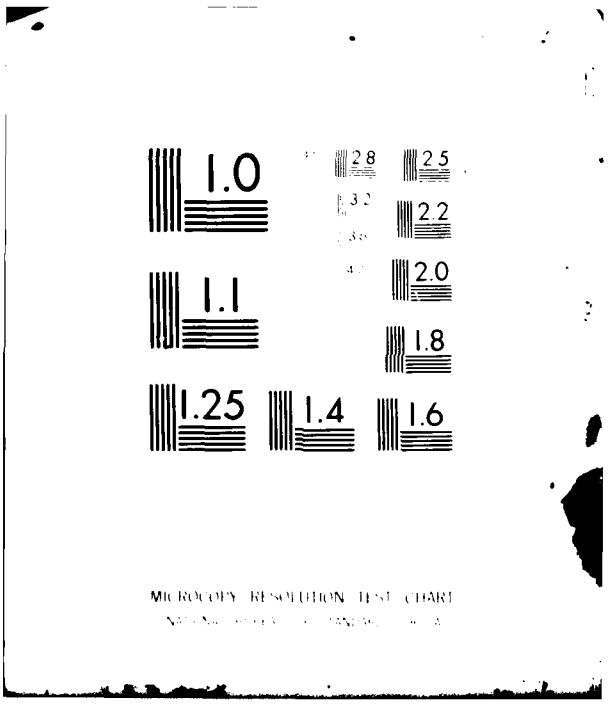
AD-A117 604 OGDEN AIR LOGISTICS CENTER HILL AFB UT PROPELLANT AN--ETC F/G 21/9.2
SURVEILLANCE REPORT. STAGE I DISSECTED MOTORS. PHASE XIII. PROP--ETC(U)
MAY 82 J A THOMPSON

UNCLASSIFIED MANPA-NR-470(82) NL

1 OF 2
AD A
117604




1.0
2.8
2.5
3.2
2.2
3.6
2.0
4.0
1.8
1.1
1.25
1.4
1.6
MICROCOPY RESOLUTION TEST CHART

HEADQUARTERS

OGDEN AIR LOGISTICS CENTER

UNITED STATES AIR FORCE

HILL AIR FORCE BASE, UTAH 84056

SURVEILLANCE REPORT

STAGE I
DISSECTED MOTORS
PHASE XIII

PROPELLANT AND COMPONENT TESTING

PROPELLANT ANALYSIS LABORATORY

MANPA REPORT NR
470(82)

May 1982

MANPA REPORT NR 470(82)
MMWRM PROJECT M24702C

SURVEILLANCE REPORT

STAGE I DISSECTED MOTORS

PHASE XIII PROPELLANT & COMPONENT TESTING

Author

JOHN A. THOMPSON, Chemist
Component and Combustion Test Unit

Engineering & Statistical Review By

JOHN K. SCAMBIA, Project Engineer
Service Engineering

EDWARD J. ERICKSON, Statistician
Data Analysis Unit

Recommended Approval By

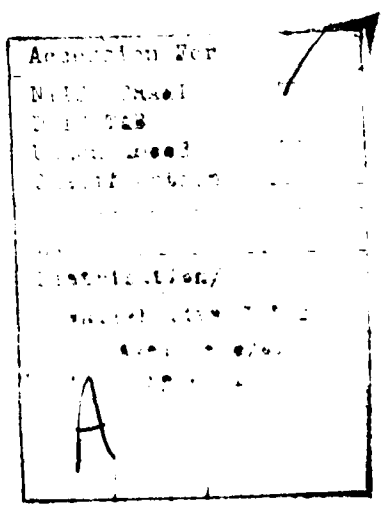
LEONIDAS A. BROWN, Chief
Component & Combustion Test Unit

Approved By

ANTHONY J. INVERSO, Chief
Propellant Analysis Laboratory

May 1982

Ind Products & Ldg Gear Division
Directorate of Maintenance
Ogden Air Logistics Center
United States Air Force
Hill Air Force Base, Utah 84056



ABSTRACT

Testing was performed to determine the useful shelf/service life for LGM-30 Stage I Rocket Motors. A three year storage program for propellant and components was started in May 1961. This program was then extended to a ten year study and later continued indefinitely to assure that a deterioration in motor physical characteristics could be detected in time to take some corrective actions before the weapon system performance deteriorated below an acceptable level.

This report covers only propellant data and limited case bond data. The malfunction of an environmental chamber destroyed component samples that had originally been part of this testing program (and the inadvertent burning of some motors during dissection reduced the material available for testing). Planned dissection of selected motors in the future will provide samples for continued component testing. Test specimens for this reporting period were obtained from motors STM-012, 0012099, and 0012199. UP-7775 block propellant was not tested since that propellant has been used up.

A new technique of Multi-symbol Regression Analysis was used to determine aging trends. Also, using a unique plotting code for each motor tested demonstrates the relationship between motors and block propellant. The plotting symbols for each motor and block propellant are listed in the statistical analyses section.

The data from this test period was combined with data from previous testing and entered into the G085 computer for storage, analysis, and regression analysis. From the statistical analysis of all data t· o date, significant degradation of the propellant does not appear likely ..r at least two years past the oldest data point.

Future testing will be conducted on dissected motors.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF FIGURES (cont)

LIST OF FIGURES (cont)

LIST OF FIGURES (cont)

LIST OF FIGURES (cont)

GLOSSARY OF TERMS AND ABBREVIATIONS

Aging Trend	A change in properties or performance resulting from aging of material or component
CSA	Cross Sectional Area
DB	Dogbone
Degradation	Gradual deterioration of properties or performance
E	Modulus (psi), defined as stress divided by strain along the initial linear portion of the curve.
EB	End Bonded
EGL	Effective Gage Length
em	Strain at maximum stress
er	Strain at rupture
"F" ratio	The ratio of the variance accounted for by the regression function to the random unexplained variance. The regression function having the most significant "F" ratio is used for plotting data. The ratio is also used in detecting significant changes in random variation between succeeding time points
JANNAF	Joint Army, Navy, NASA, Air Force Committee
MANPA	Propellant Lab Section at Ogden Air Logistics Center
Ogden ALC	Ogden Air Logistics Center, Air Force Logistics Command
r or R	The Correlation Coefficient is a measure of the degree of closeness of the linear relationship between two variables
Regression Equation	The general form of the regression equation is $Y = a + bx$
Regression Line	Line representing mean test values with respect to time
S_b	Standard error of estimate of the regression coefficient

GLOSSARY OF TERMS AND ABBREVIATIONS (cont)

S_e or $S_{Y.X}$	Standard deviation of the data about the regression line
Sm	Maximum Stress
Sr	Stress at rupture
Standard Deviation (S_y)	Square root of variance
Strain Rate	Crosshead speed divided by the EGL
"t" test	A statistical test used to detect significant differences between a measured parameter and an expected value of the parameter (determines if regression slope differs from zero at the 95% confidence level)
Variance	The sum of squares of deviations of the test results from the mean of the series after division by one less than the total number of test results
3 Sigma Band	The area between the upper and lower 3 sigma limit. It can be expected that 99.73% of the inventory represented by the test samples would fall within this range assuming that the population is normally distributed.
90-90 Band	It can be stated with 90% confidence that 90% of the inventory represented by the test samples would fall within this range assuming that the population is normally distributed

INTRODUCTION

A. PURPOSE

This report contains test data from samples of LGM-30 Stage I, Wings I-V TP-H1011 propellant and case bond specimens. Testing was performed by the Propellant Analysis Laboratory (MANPA) for the Engineering and Reliability Branch of the Airmunitions Management Division (MMWRM) under Project M24702C. This report is the thirteenth in this series. Data from this test period and propellant test data from the twelve previous reports were entered into the G085 computer for regression analysis. The regressions are shown in this report.

B. TEST PROGRAM:

The LGM-30 Laboratory and Component Program includes the testing of materials used in the main case and main grain propellant. Table 1 outlines the test program.

Propellant for testing was obtained from three dissected motors; STM-012, a motor prepared by Thiokol specifically for dissection; S/N 0012099, a SLIM motor and S/N 0012199 which was selected for dissection.

C. HISTORICAL BACKGROUND:

In May 1961, Thiokol began a three year LGM-30 laboratory storage and test program to determine the rate of degradation with age for Stage I materials. During June 1962 and again in August 1963, additional samples were included. New samples were added in July and August 1964 when the surveillance test program was extended to ten years (Test Plan 0717-62-0967, 53-8). The samples added to the inventory in 1964 were considered to be a new population, but were combined in regression analysis with the three dissected motors.

The history of testing of these materials is found in MQQP Report Nrs. 109A(67), 144(68), 208(71), and MANCP Report Nr. 358(76). Physical transfer of the specimens from Thiokol to Ogden ALC was made in June 1967.

STATISTICAL ANALYSIS

The objective of this statistical analysis was to determine whether or not any aging trends are demonstrated by accumulated test data in order to assist Service Engineering to more accurately predict motor serviceability.

Propellant was made available for testing and statistical analysis was performed on the resultant data in order to obtain an overall view of the aging trends affecting the Stage I Dissected Motor Program. The sampling consisted of data from two dissected operational motors (0012099 and 0012199), and one motor (STM-012) was prepared by Thiokol specifically for the dissection program. By using TP-H1011 propellant from Stage I Dissected Motors, a normal distribution population was assumed and the data from these motors were statistically combined.

A new technique of Multi-symbol Regression Analysis Program was used to determine aging trends. The sampling is combined for each test parameter in a single regression analysis. The linear equation ($Y = a + bX$) was found to be the best fit model for the data in this report. A composite population aging regression trend line is then calculated.

The Multi-symbol Program uses a unique plotting code for each motor data on the regression plots. This method of data plotting allows a visual display of the overall relationship between different motors and how they relate to the overall least square aging trend line.

The regression program uses an analysis with individual data points from different time periods combined to establish a least squares aging trend line for the overall data. The variance about the regression line, obtained using individual values of the dependent variable, was used to compute a tolerance interval such that at the 90% confidence level 90% of the population falls within this interval. This tolerence interval was

extrapolated to a maximum of 24 months to give an indication of the statistical significance of the slope of any aging trends. The computer tolerance interval about the composite regression line is wider than what the tolerance interval would be about any individual motor regression line because of the increased data spread introduced by combining different motors. The 't' values and the significance of this statistic, which are reported for each regression model, gives an indication of the "statistical significance" of the slope of the aging trend in the Y-axis. Data and regression trend lines were plotted utilizing an IBM-360/65 computer.

A motor-to-motor regression comparison was performed using the Analysis of Covariance (Table 2). The key LRSLA properties being tracked in the surveillance program were selected for this test. The motors indicate having been biased differently at some point in time. None of the 14 tests were significantly equal. The data from these motors should not be statistically combined in the future. Table 3 shows an abnormal difference visually displayed through the use of multi-symbol plotting of the three different motors. The comparisons indicate no homogenity of variance between motors.

ORIGIN SYMBOL TABLE

Origin	DOM	Wing	Symbol
0012099	63166	2	0
0012199	63227	2	1
STM-012	61221	1	S

TABLE 1
TEST PROGRAM

Test	Conditions	Config-uration	Spec Per Condition	Total Specs
Case Bond Constant Rate Tensile	180°F, 0 psig 0.002 in/min CHS	Poker Chip	12	12
Case Bond Constant Rate Shear	180°F, 0 psig 0.002 in/min CHS	Poker Chip W/22° Groove	12	12
Stress Relaxation Modulus	-20°F, 300 psig, 3% Strain to 10,000 sec	JANNAF 1/2" DB Wood-End Tab	9	9
Stress Relaxation Modulus	77, 180°F, 0 psig, 3% Strain to 10,000 sec	JANNAF 1/2" DB Wood-End Tab	9	18
Tear Energy	30°F, 0 psig, 2.0 in/min CHS	Tear Specimen	9	9
Tear Energy	77°F, 0 psig, 0.2 & 2.0 in/min CHS	Tear Specimen	9	18
Tear Energy	180°F, 0 psig, 0.02 &0.002 in/min CHS	Tear Specimen	9	18
Low Rate Hydro-static Tensile	30 & 77°F, 800 psig 2.0 & 20 in/min CHS	JANNAF DB	9	18
Low Rate Tensile	77°F, 0 psig, 0.02, 0.2 & 2.0 in/min CHS	JANNAF DB	9	18
Very Low Rate Tensile	180°F, 0 psig 0.002 in/min CHS	JANNAF DB	9	18
Triaxial Low Rate Tensile	30 & 77°F, 800 psig 2.0 & 20 in/min CHS	3/4" GL Rail End-Bonded	9	18
Biaxial Low Rate Tensile	77°F, 0 psig, 0.2 & 2.0 in/min CHS	3/4" GL Rail End-Bonded	9	18
Biaxial Very Low Tensile	180°F, 0 psig 0.02 & 0.002 in/min CHS	3/4" GL Rail End-Bonded	9	18
TCLE*	5°C rise/min	0.200 Wafer (about 16 sq in)	9	9
Sol Gel	77°F ± 2°F 1 in/min CHS	1/2 x 1/2 x 1/2"	9	9

*One package of wafers will be delivered to the laboratory and the specimens will be cut from the wafers.

TEST RESULTS

Regression analysis is the method of evaluation used in the analysis of the test results. Regressions with the three motors combined (STM-012, 0012099 and 0012199) are presented as in the previous report (MAKPH Report Nr. 452(81)). In addition, regressions for the separate motors are also presented in this report for the testing that is also in the LRSLA program.

A. TENSILE:

1. Low Rate Tensile (2.0 in/min):

The strain at maximum stress regression (figure 1) for the combined group of all three motors shows a non-significant trend line slope. The regression trend lines for the individual motors, 0012099 (figure 1-A) and STM-012 (figure 1-C)show non-significant slopes. However, the individual trend line slope for motor 0012199 (figure 1-B) shows a significantly decreasing trend line slope.

The strain at rupture regression (figure 3) for the combined group of all three motors shows a non-significant trend. The regression trend line for motor 0012099 (figure 3-A) also shows a non-significant slope. However, the individual trend line slopes for motors 0012199 (figure 3-B) and STM-012 (figure 3-C) show a significant negative trend line.

Maximum stress (figure 2), stress at rupture (figure 4), and modulus (figure 5) for the combined group of all three motors show a non-significant trend line slope.

2. Low Rate Tensile (20.0 in/min):

The strain at maximum stress regression (figure 6) for the composite of all three motors shows a significant negative trend line slope. The regressions for the individual motors 0012099 (figure 6-A) and 0012199 (figure 6-B)show negative trends. The individual trend line for motor

STM-012 (figure 6-C) is not significant.

The maximum stress (figure 7) for the composite group is not significant. Strain at rupture (figure 8) for the composite group shows a significant decreasing trend. Motors 0012099 (figure 8-A) and 0012199 (figure 8-B) also indicate a trend in the negative direction. However, motor STM-012 (figure 8-C) has a non-significant slope. Stress at rupture (figure 9) and modulus (figure 10) composite trend lines show a statistically significant decreasing and increasing trend respectively.

3. High Rate Tensile (1000 in/min CHS):

No significant slope direction is shown for the high rate composite regressions (figures 11 thru 15).

4. High Rate Triaxial Tensile (1000 in/min CHS 600 psi):

The composite regressions for strain at maximum stress (figure 16) and strain at rupture (figure 18) show a statistically significant increase. The composite regressions for maximum stress (figure 17) and stress at rupture (figure 19) have non-significant trend lines. Modulus (figure 20) shows a trend line with a decreasing slope in the negative direction.

5. Case Bond Tensile:

The composite regression for motors 0012199 and STM-012 (figure 21) and the individual regression for motor STM-012 (figure 21) show negative trend line slopes. The regression trend line of individual motor 0012199 (figure 21-A) shows no significance.

For motor 0012199, five specimens failed 100% in the adhesive liner to propellant with one specimen failing 100% in the adhesive liner to case.

For motor STM-012, the failure mode for all specimens was 100% adhesive liner to propellant.

B. CREEP:

The composite regressions for the 10 and 12 pound load test show a statistically significant decreasing trend line slope (figures 22 thru 29).

C. STRESS RELAXATION:

The stress relaxation modulus composite regressions at 3% strain show a statistically significant positive trend at 10 and 50 seconds with no significant trend direction at 100 and 1000 seconds (figures 30 thru 33). The 5% strain composite regressions at 10 seconds show a significant positive trend with no significant trend at 50, 100 and 1000 seconds (figures 34 thru 37).

D. CONSTANT STRAIN:

The composite regression (figure 38) and the individual motor STM-012 (Figure 38-B) show a negative directed regression trend. The individual regression trend line for motor 0012199 (figure 38-A) is not significant.

E. HARDNESS (Shore A):

The 10 second composite regression (figure 39) and individual motor STM-012 regression (figure 39-C) have negative trend lines. Individual motors 0012099 (figure 39-A) and 0012199 (figure 39-B) are not significant.

F. DYNAMIC RESPONSE:

The composite regressions for loss tangent at 200 HZ (figure 40) and 400 HZ (figure 41) are not significant. The storage shear modulus composite regressions for 200 HZ (figure 42) and 400 HZ (figure 43) have significant decreasing trends in the negative direction.

G. TEAR ENERGY:

The composite regression trend line is not significant (figure 44).

H. SOL GEL:

The composite regression trend lines for % extractables and weight swell ratio have significant positive trends while density and crosslink density have negative trend line slopes (figures 45 thru 48).

I. BURNING RATE:

The 500 psi composite regression (figure 49) and the individual motor 0012099 regression (figure 49-A) show a non-significant trend. The individual motor 0012199 (figure 49-B) has a positive trend while motor STM-012 has a negative trend line.

At 1000 psi, the composite regression (figure 50) and individual motor 0012099 (figure 50-A) have significant negative slope direction. The individual motor regression for motor 0012199 (figure 50-B) is not significant. The individual regression for STM-012 (figure 50-C) shows a significant negative trend line.

J. HEAT OF EXPLOSION:

The composite regression (figure 51) and individual regression for motor STM-012 (figure 51-C) show significantly positive trend lines. The regressions for the individual motors 0012099 (figure 51-A) and 0012199 (figure 51-B) are not significant.

K. DIFFERENTIAL THERMAL ANALYSIS (DTA):

The endotherm composite regression (figure 52) and the individual regressions for motor 0012099 (figure 52-A) and 0012199 (figure 52-B) have significantly decreasing trend lines. Motor STM-012 is not significant.

The exotherm composite regression (figure 53) and individual motor 0012199 (figure 53-B) are not significant. The individual motors 0012099 (figure 53-A) and STM-012 (figure 53-C) have significantly negative trends.

The ignition temperature composite regression (figure 54) and individual motor 0012199 (figure 54-B) regression have non-significant trend lines. Individual motors 0012099 (figure 54-A) and STM-012 (figure 54-C) regressions have statistically significant positive trend line slopes.

DISCUSSION OF TEST RESULTS

A. TENSILE SUMMARY:

1. Combined Group Motors:

Where statistically significant changes are indicated, the changes are gradual and no problems are foreseen. The regression trends are not consistent when comparing the respective strains and stresses obtained under different conditions as seen in First Stage block testing. The most probable reason for this inconsistency is the variance between motors as shown in Table 2.

2. Individual Motors;

For those regressions where statistically significant trends are seen, the changes are gradual and no problems are indicated. These regressions show the same general trends as seen in the block propellant testing. The individual motor regressions show the propellant with less strain capability and higher tensile strength as the age increases.

B. THERMAL AND COMBUSTION SUMMARY

1. Combined Group Motors:

From the analysis of the test data, the thermal properties are not undergoing a drastic change, with respect to age, at this time.

2. Individual Motors:

Only burning rate and heat of explosion regressions are shown. Where a statistically significant change is shown, the trends are gradual and no problems are evident. Moreover, the significant gradual changes are not statistically comparable with the regressions from the combined group motors.

TABLE 2

ANALYSIS OF COVARIANCE SUMMARY
Comparison of Regressions Between 0012099, 0012199 & STM-012

Test	Residual Mean Squares 0012099	0012199	STM-012	Difference Between Residual Trend Lines Variance	Slope	Elevation
Tensile:						
Strain at Max Stress, 77°F, 2.0 in/min	.00029	.00025	.00016	S		
Strain at Rupture, 2.0 in/min, 77°F	.00046	.00047	.00032	S		
Strain at Max Stress, 77°F, 20.0 in/min	.00026	.00041	.00071	S		
Strain at Rupture, 77°F, 20.0 in/min	.00047	.00090	.00048	S		
Case Bond, 77°F, 0.2 in/min		733	149	S		
Constant Strain, 77°F Strain at Rupture		0.96	7.80	S		
Hardness, Shore A, 77°F, 10 sec	7.09	5.54	6.16	NS	NS	S
Burn Rate						
500 psi Initial Pressure	.00015	.00071	.00056	S		
1000 psi Initial Pressure	.00017	.00040	.00014	S		
Ignitability, Ignition Threshold Point 168	53.2	5.69	28.8	S		
Heat of Explosion	56.4	114.5	285.7	S		
DTA						
Endotherm 1	5.25	1.84	5.03	S		
Exotherm 1	4.14	4.49	14.16	S		
Ignition Temperature	169.5	114.4	38.5	S		

S = Data are significantly different
NS = Data not significant

NOTE: Analysis performed at the 5% significant level

TABLE 3

REGRESSION TREND LINE SUMMARY

Test	Composite Three Motors	Individual Motors 0012099	0012199	STM-012
Low Rate Tensile, 77°F, 2.0 in/min				
Strain at Max Stress	NS	NS	-	NS
Maximum Stress	NS			
Strain at Rupture	NS	NS	-	-
Stress at Rupture	NS			
Modulus	NS			
Low Rate Tensile, 77°F, 20.0 in/min				
Strain at Max Stress	-	-	-	NS
Maximum Stress	NS			
Strain at Rupture	-	-	-	NS
Stress at Rupture	-			
Modulus	+			
High Rate Tensile, 77°F, 1750 in/in/min				
Strain at Max Stress	NS			
Maximum Stress	NS			
Strain at Rupture	NS			
Stress at Rupture	NS			
Modulus	NS			
High Rate Triaxial Tensile, 1750 CHS, 600 psi, 77°F				
Strain at Max Stress	+			
Maximum Stress	NS			
Strain at Rupture	+			
Stress at Rupture	NS			
Modulus	-			
Case Bond Tensile, 77°F	-		NS	-
Creep, 10 lb Load, 10 sec	-			
20 sec	-			
1000 sec	-			
10,000 sec	-			
Creep, 12 lb Load, 10 sec	-			
20 sec	-			
1000 sec	-			
% Strain at Rupture	-			
Stress Relaxation, 3% Strain, 10 sec	+			
50 sec	+			
100 sec	NS			
1000 sec	NS			
Stress Relaxation, 5% Strain, 10 sec	+			
50 sec	NS			
100 sec	NS			
1000 sec	NS			

TABLE 3 (cont)

Test	Composite Three Motors	Individual Motors 0012099	0012199	STM-012
Constant Strain, 77°F	-		NS	-
Hardness, Shore A, 77°F, 10 sec	-	NS	NS	-
Dynamic Response				
Loss Tangent, 200 HZ	NS			
Loss Tangent, 400 HZ	NS			
Storage Shear Modulus, 200 HZ	-			
Storage Shear Modulus, 400 HZ	-			
Tear Energy	NS			
Sol Gel				
% Extractables	+			
Weight Swell Ratio	+			
Density	-			
Crosslink Density	-			
Burning Rate				
500 psi	NS	NS	+	-
1000 psi	-	-	NS	-
Heat of Explosion	+	NS	NS	+
DTA				
Endotherm 1	-	-	-	NS
Exotherm 1	NS	-	NS	-
Ignition Temperature	NS	+	NS	+

NS = Non-significant trend from a line of zero slope.
+ = Significant slope in a positive direction.
- = Significant slope in a negative direction.

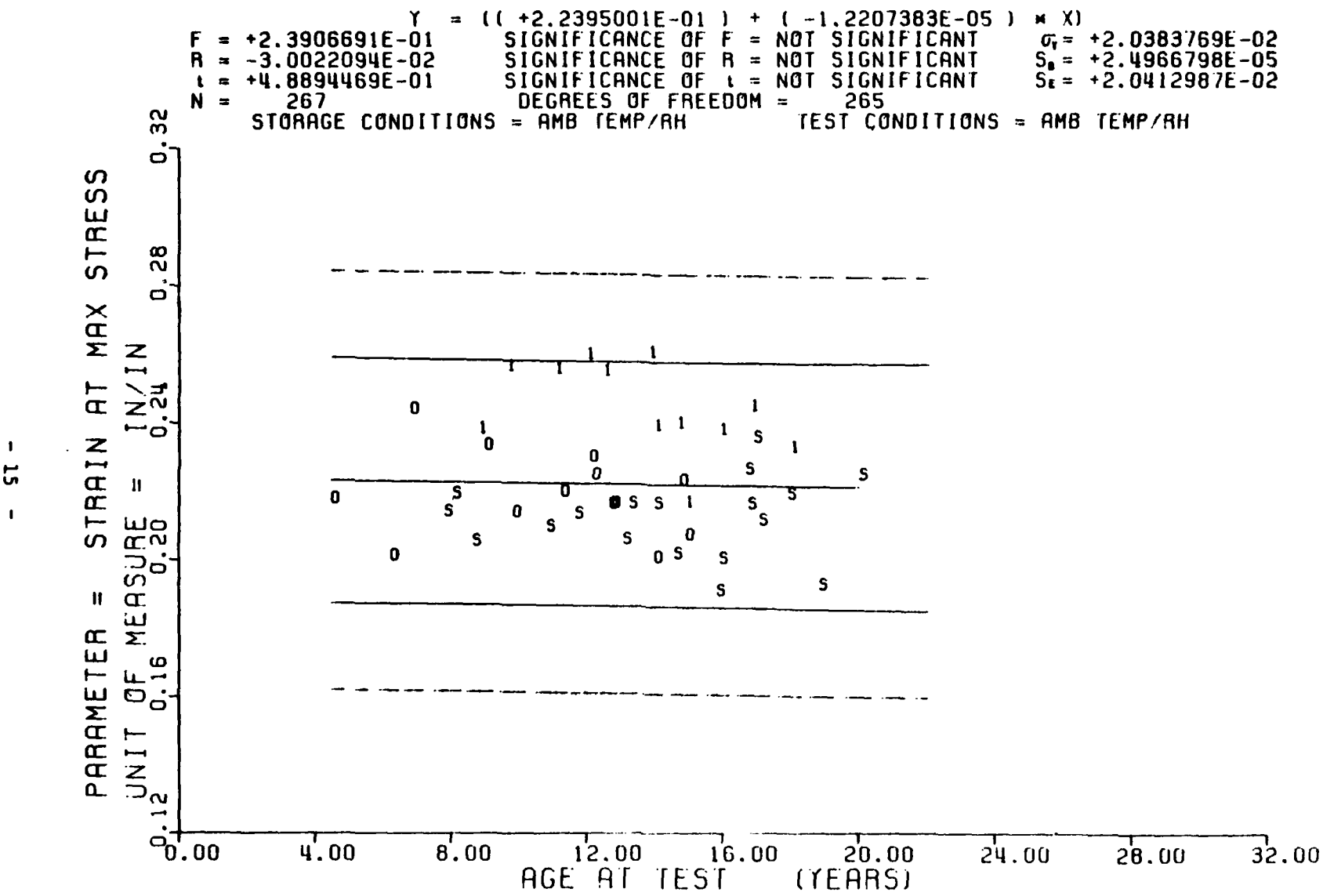

Y = ((+2.2395001E-01) + (-1.2207383E-05) * X)
F = +2.3906691E-01 SIGNIFICANCE OF F = NOT SIGNIFICANT σ1 = +2.0383769E-02
R = -3.0022094E-02 SIGNIFICANCE OF R = NOT SIGNIFICANT Sb = +2.4966798E-05
t = +4.8894469E-01 SIGNIFICANCE OF t = NOT SIGNIFICANT Se = +2.0412987E-02
N = 267 DEGREES OF FREEDOM = 265
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRAIN AT MAX STRESS
UNIT OF MEASURE = IN/IN
0.32
0.28
0.24
0.20
0.16
0.12
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISSECTED MOTORS,LOW RATE CHS=2.0 IN/MIN,STRAIN MAX STRESS

Figure 1

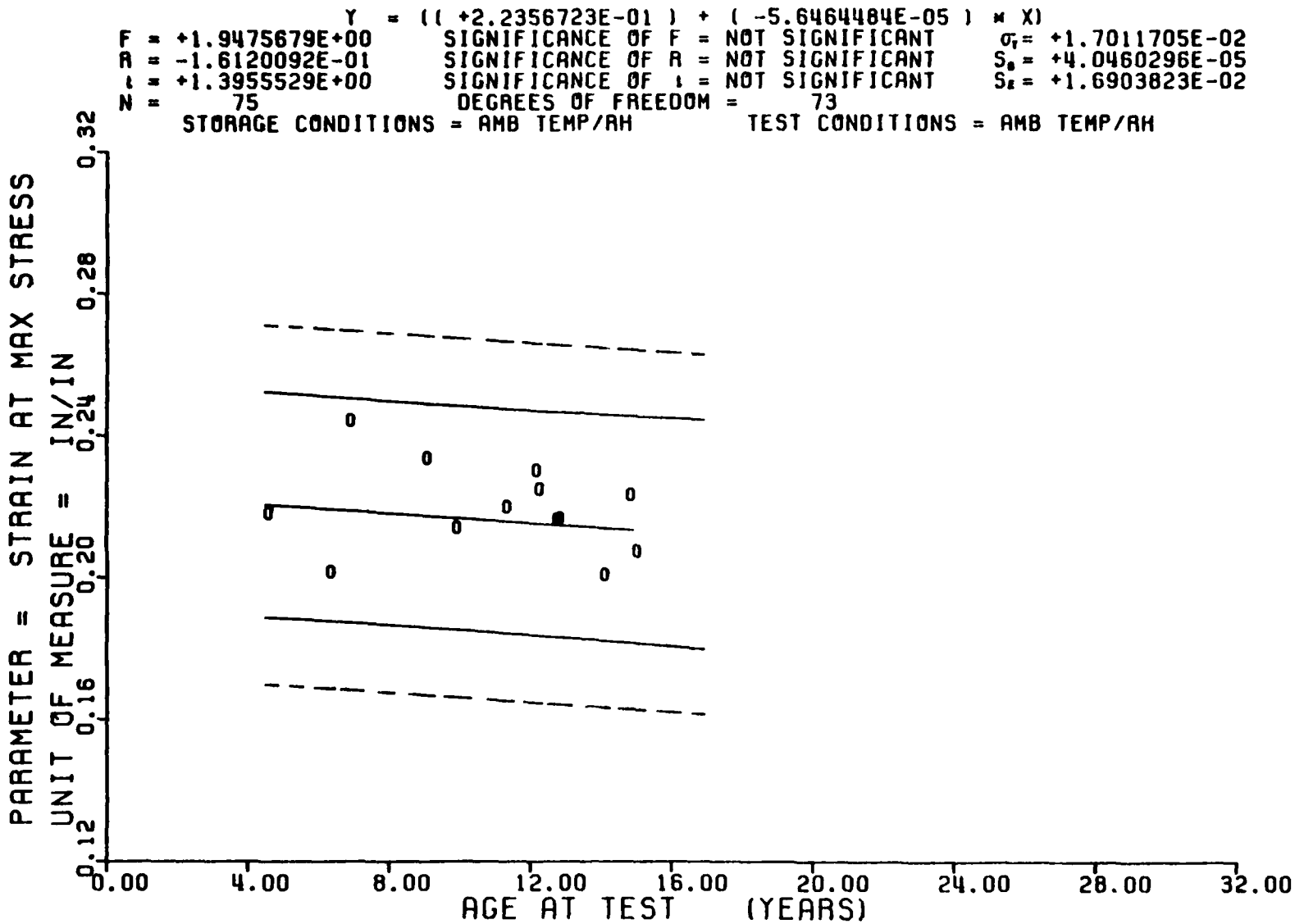

Y = ((+2.2356723E-01) + (-5.6464484E-05) * X)
F = +1.9475679E+00 SIGNIFICANCE OF F = NOT SIGNIFICANT σr = +1.7011705E-02
R = -1.6120092E-01 SIGNIFICANCE OF R = NOT SIGNIFICANT Sb = +4.0460296E-05
t = +1.3955529E+00 SIGNIFICANCE OF t = NOT SIGNIFICANT Sx = +1.6903823E-02
N = 75 DEGREES OF FREEDOM = 73
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRAIN AT MAX STRESS
UNIT OF MEASURE = IN/IN
0.32
0.28
0.24
0.20
0.16
0.12
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISSECTED MOTOR=0012099,LOW RATE CHS=2.0 IN/MIN,STRAIN MAX STRESS

Figure 1-A

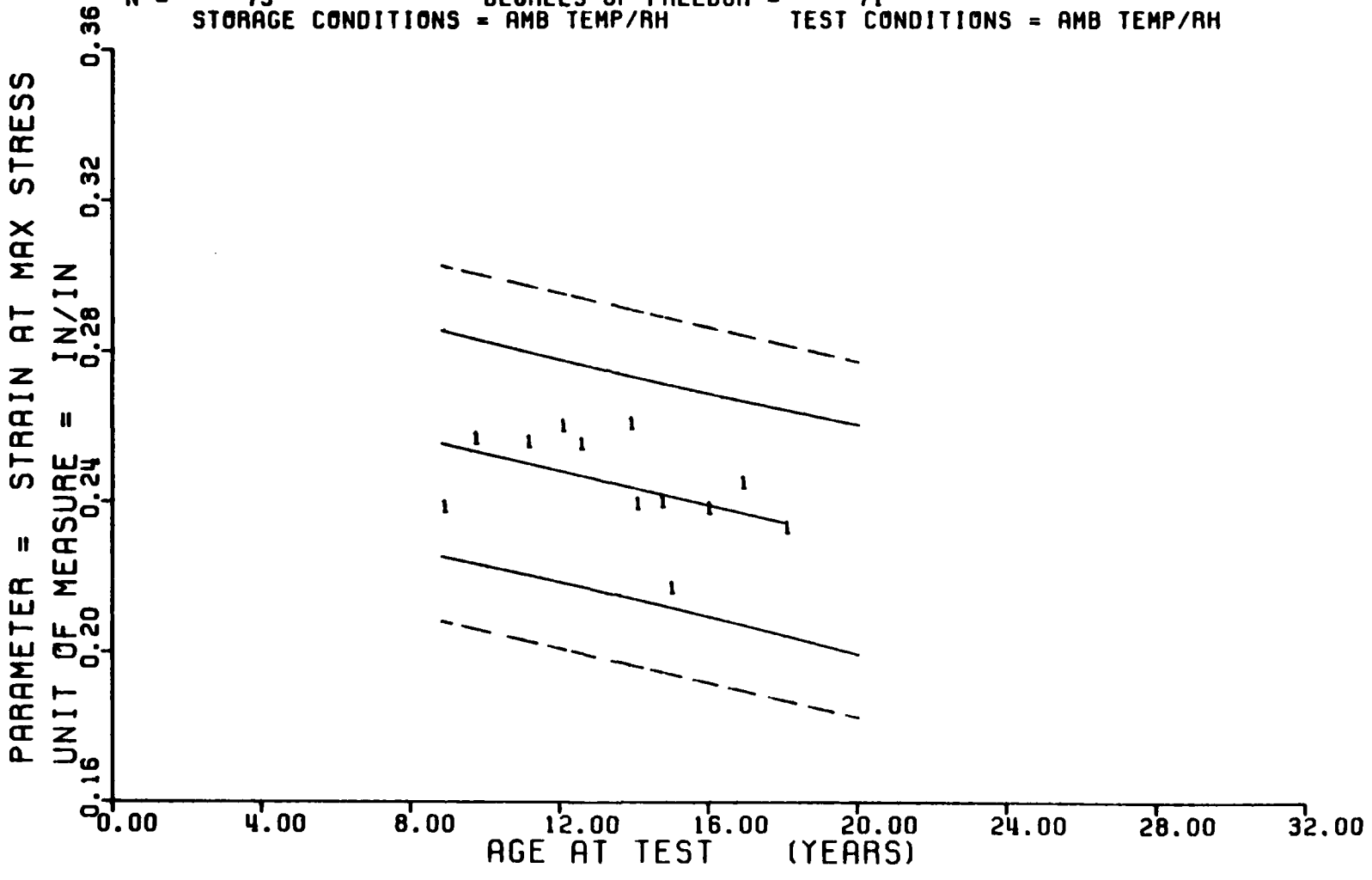

Y = ((+2.7554029E-01) + (-1.9022784E-04) * X)
F = +1.1965652E+01 SIGNIFICANCE OF F = SIGNIFICANT σr = +1.6920217E-02
R = -3.7976857E-01 SIGNIFICANCE OF R = SIGNIFICANT Sb = +5.4992809E-05
t = +3.4591404E+00 SIGNIFICANCE OF t = SIGNIFICANT Sε = +1.5762424E-02
N = 73 DEGREES OF FREEDOM = 71
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRAIN AT MAX STRESS
UNIT OF MEASURE = IN/IN
0.16
0.20
0.24
0.28
0.32
0.36
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISSECTED MOTOR=0012199,LOW RATE CHS=2.0 IN/MIN,STRAIN MAX STRESS

Figure 1-B

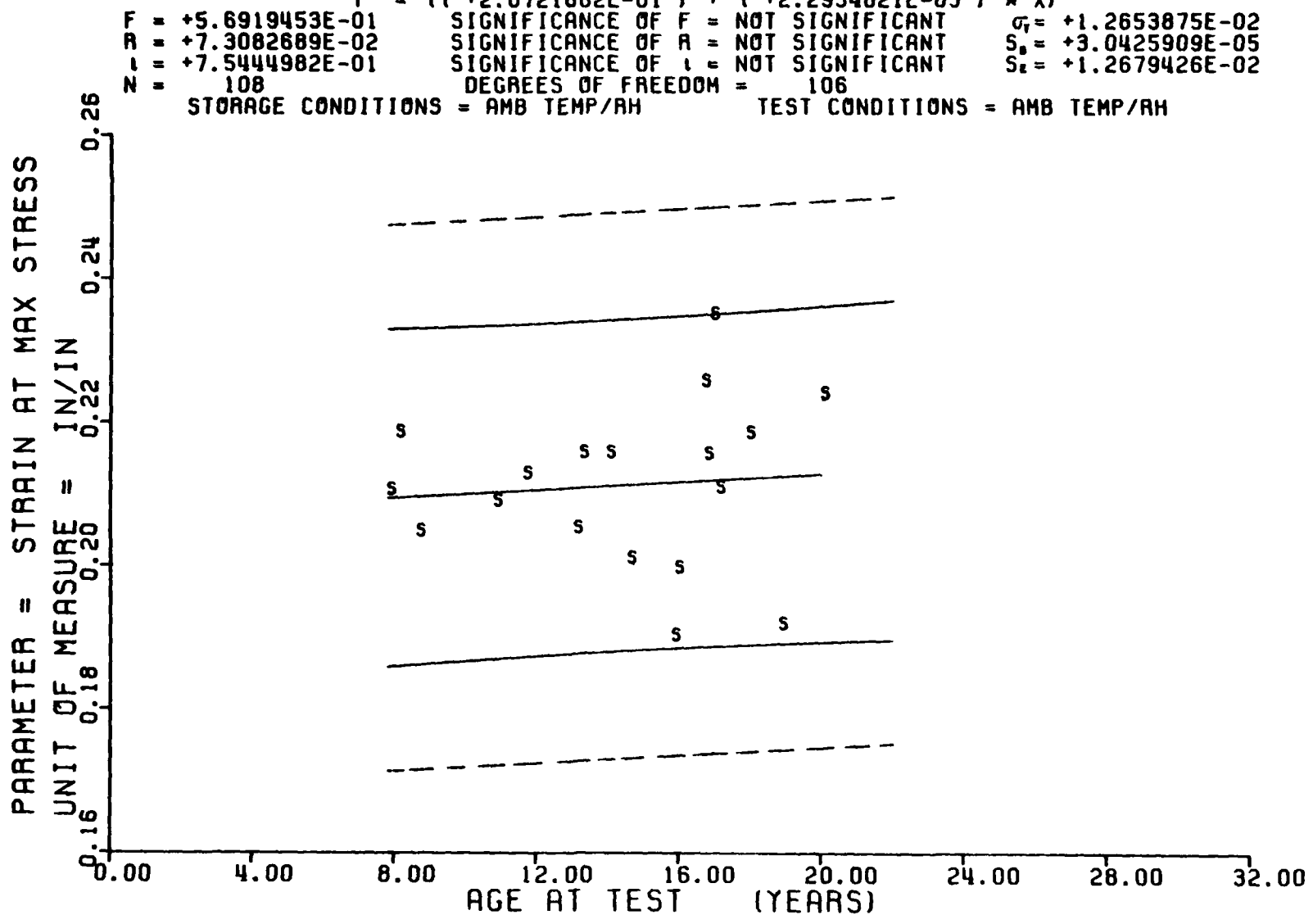

Y = ((+2.0721862E-01) + (+2.2954821E-05) * X)
F = +5.6919453E-01 SIGNIFICANCE OF F = NOT SIGNIFICANT σT = +1.2653875E-02
R = +7.3082689E-02 SIGNIFICANCE OF R = NOT SIGNIFICANT Sb = +3.0425909E-05
t = +7.5444982E-01 SIGNIFICANCE OF t = NOT SIGNIFICANT Se = +1.2679426E-02
N = 108 DEGREES OF FREEDOM = 106
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRAIN AT MAX STRESS
UNIT OF MEASURE = IN/IN
0.26
0.24
0.22
0.20
0.18
0.16
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISSECTED MOTOR=STM-012,LOW RATE CHS=2.0 IN/MIN,STRAIN MAX STRESS

Figure 1-C

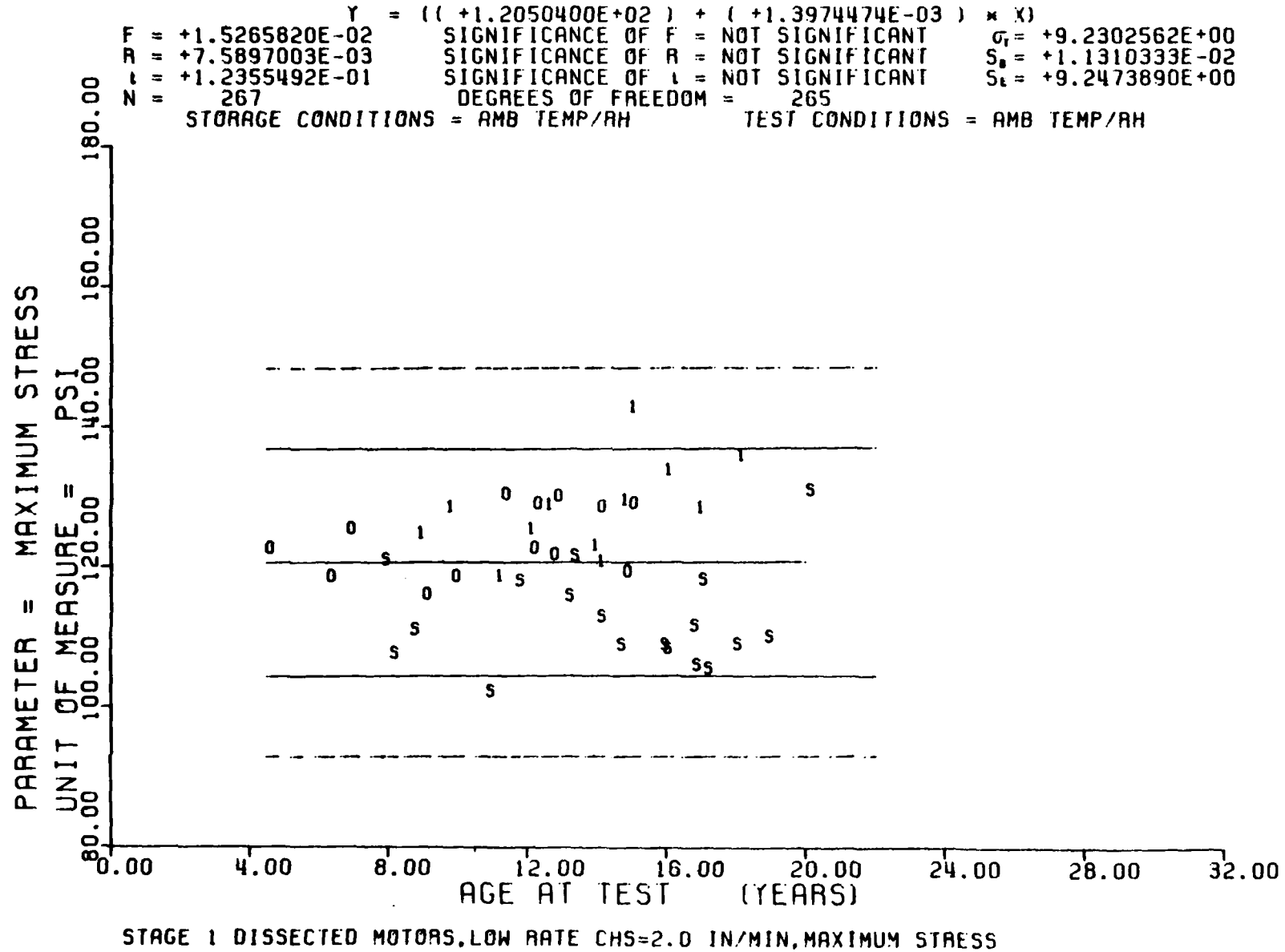
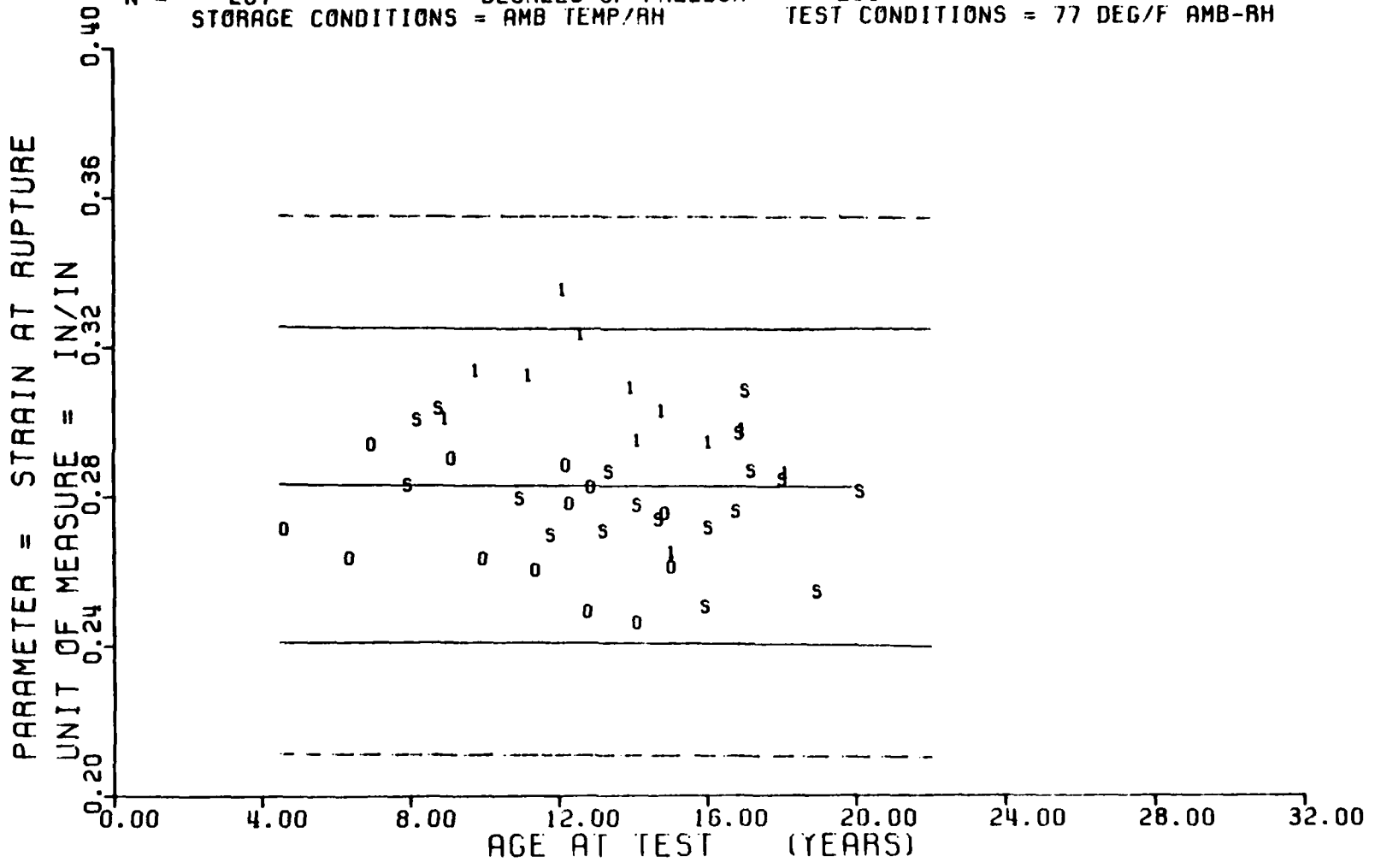

Y = ((+1.2050400E+02) + (+1.3974474E-03) * X)
F = +1.5265820E-02 SIGNIFICANCE OF F = NOT SIGNIFICANT σ = +9.2302562E+00
R = +7.5897003E-03 SIGNIFICANCE OF R = NOT SIGNIFICANT S = +1.1310333E-02
t = +1.2355492E-01 SIGNIFICANCE OF t = NOT SIGNIFICANT S = +9.2473890E+00
N = 267 DEGREES OF FREEDOM = 265
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = MAXIMUM STRESS
UNIT OF MEASURE = PSI
180.00
160.00
140.00
120.00
100.00
80.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISSECTED MOTORS,LOW RATE CHS=2.0 IN/MIN,MAXIMUM STRESS

Figure 2



STAGE 1 DISSECTED MOTORS,LOW RATE CHS=2.0 IN/MIN,STRAIN AT RUPTURE

Figure 3

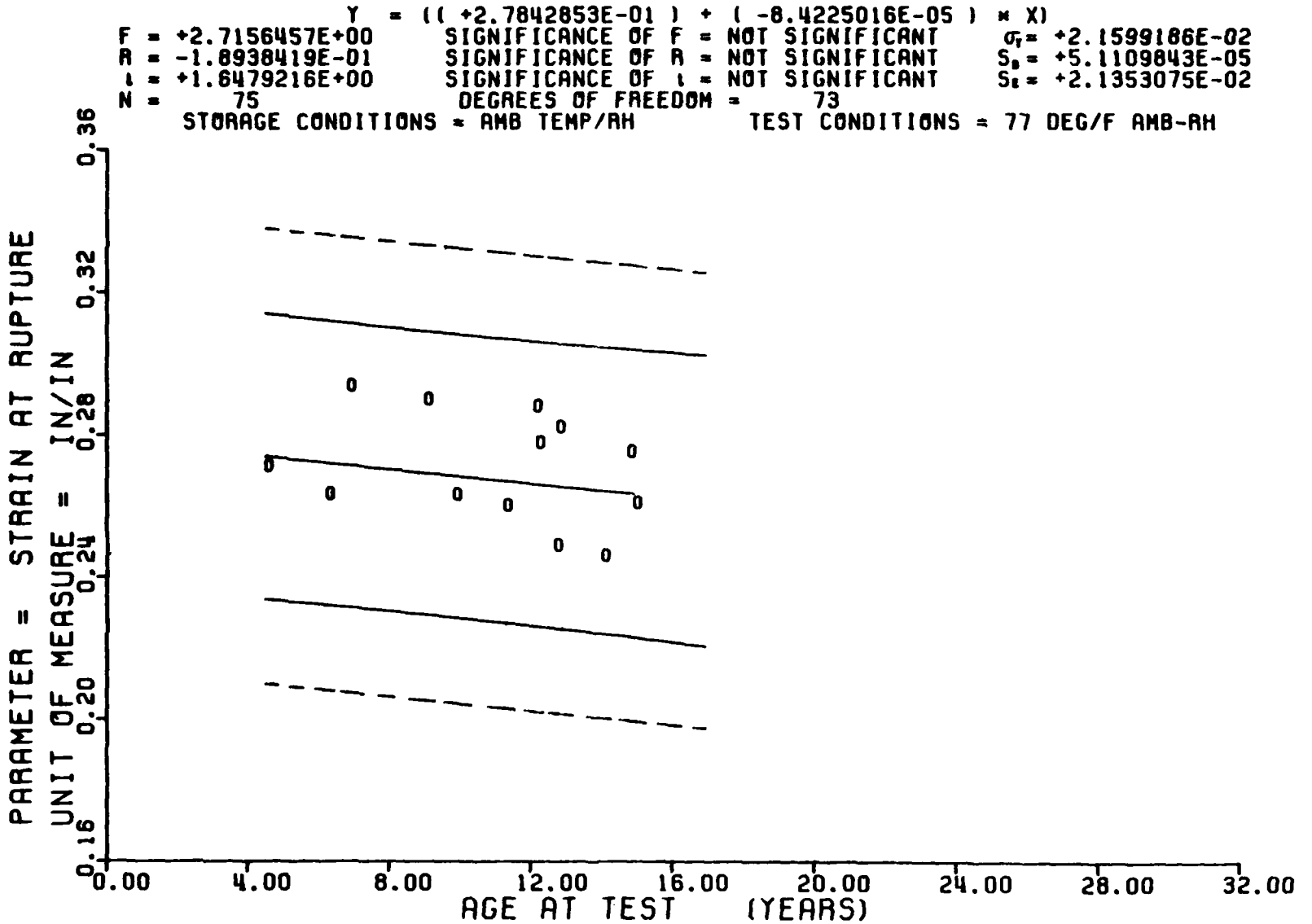

Y = ((+2.7842853E-01) + (-8.4225016E-05) * X)
F = +2.7156457E+00 SIGNIFICANCE OF F = NOT SIGNIFICANT σr = +2.1599186E-02
R = -1.8938419E-01 SIGNIFICANCE OF R = NOT SIGNIFICANT Sb = +5.1109843E-05
t = +1.6479216E+00 SIGNIFICANCE OF t = NOT SIGNIFICANT St = +2.1353075E-02
N = 75 DEGREES OF FREEDOM = 73
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = 77 DEG/F AMB-RH
PARAMETER = STRAIN AT RUPTURE
UNIT OF MEASURE = IN/IN
0.36
0.32
0.28
0.24
0.20
0.16
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISSECTED MOTOR=0012099,LOW RATE CHS=2.0 IN/MIN,STRAIN AT RUPTURE

Figure 3-A

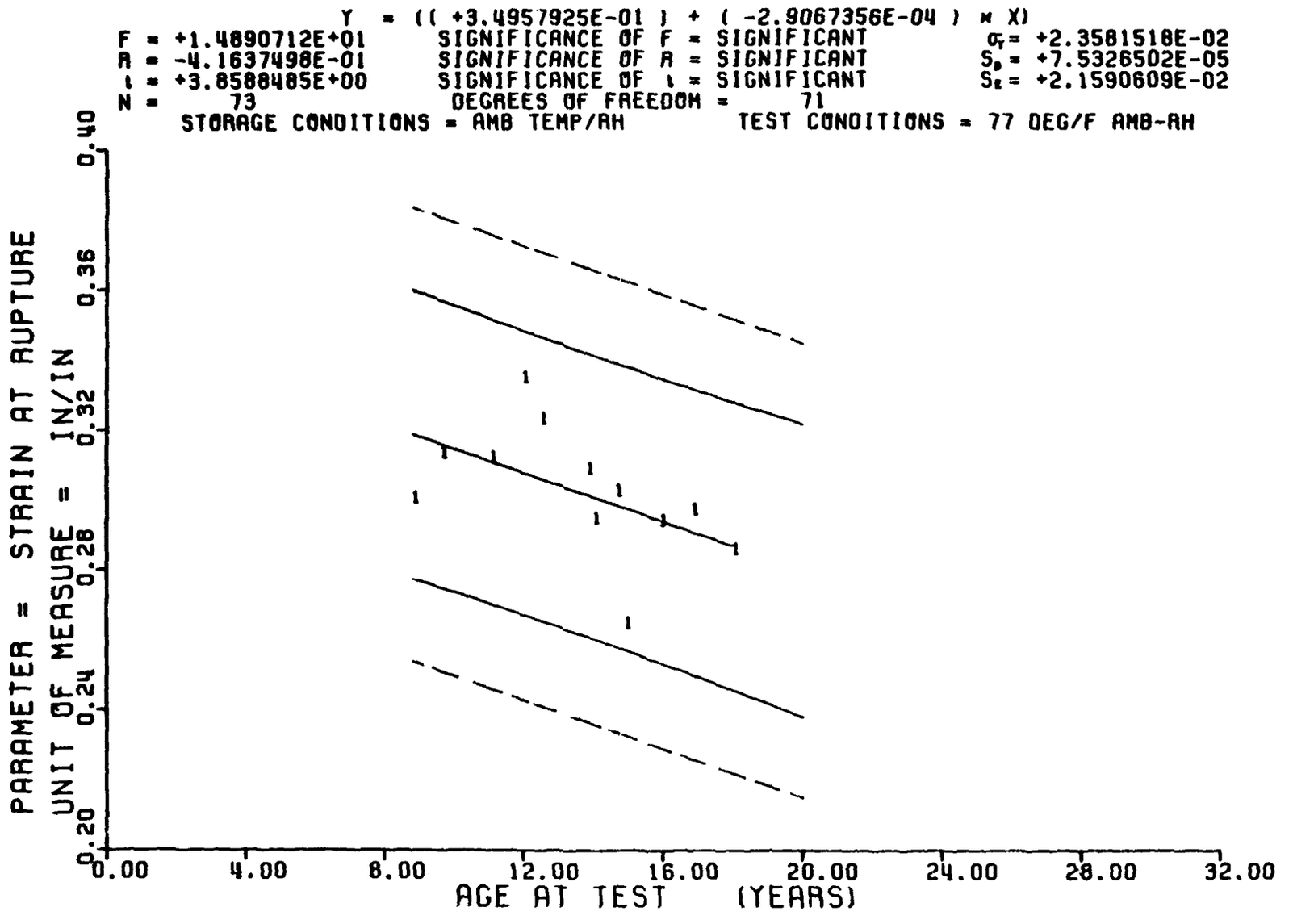

Y = ((+3.4957925E-01) + (-2.9067356E-04) * X)
F = +1.4890712E+01 SIGNIFICANCE OF F = SIGNIFICANT σr = +2.3581518E-02
A = -4.1637498E-01 SIGNIFICANCE OF A = SIGNIFICANT Sa = +7.5326502E-05
t = +3.8588485E+00 SIGNIFICANCE OF t = SIGNIFICANT St = +2.1590609E-02
N = 73 DEGREES OF FREEDOM = 71
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = 77 DEG/F AMB-RH
PARAMETER = STRAIN AT RUPTURE
UNIT OF MEASURE = IN/IN
0.40
0.36
0.32
0.28
0.24
0.20
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISSECTED MOTOR=0012199,LOW RATE CHS=2.0 IN/MIN,STRAIN AT RUPTURE

Figure 3-B

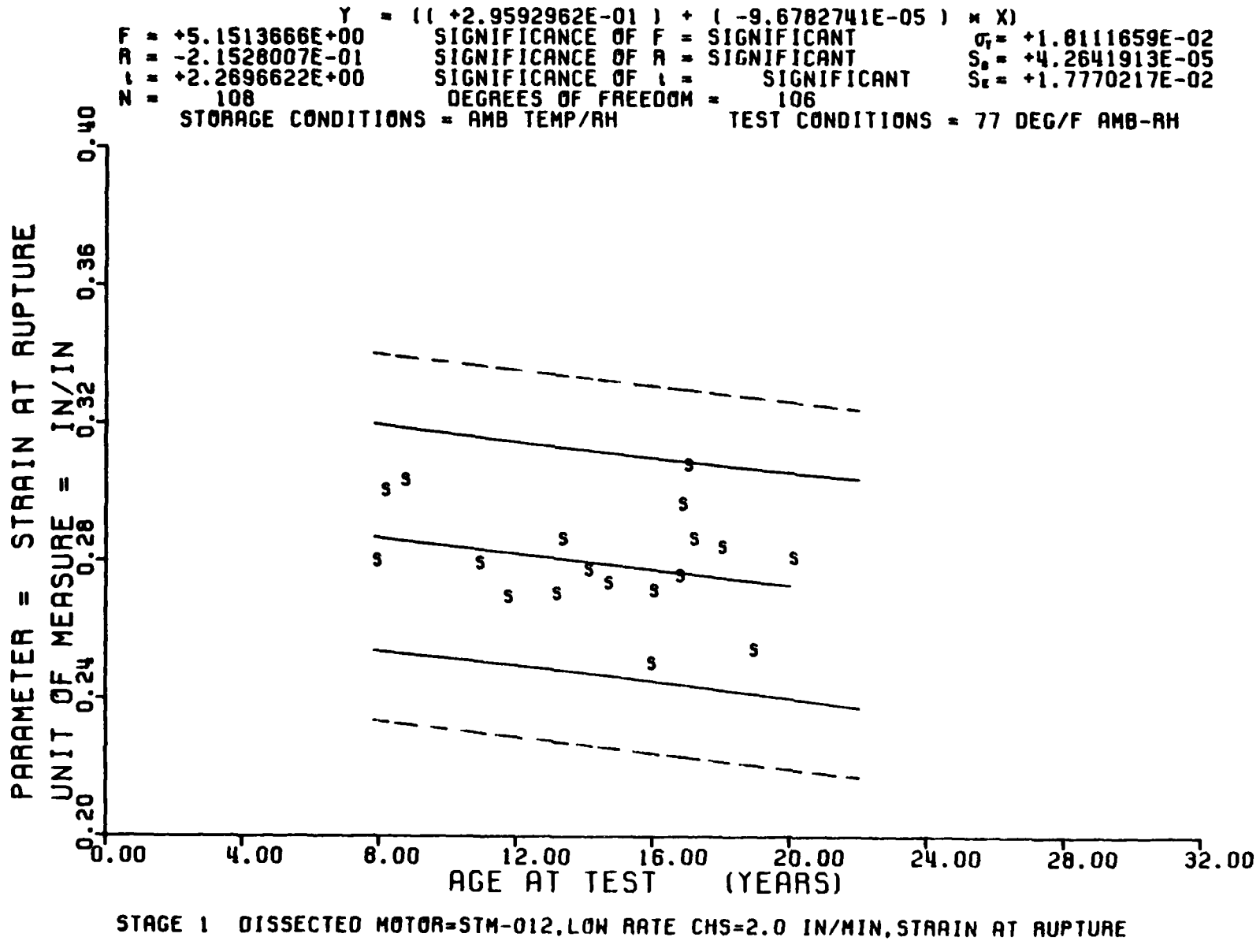

Y = ((+2.9592962E-01) + (-9.6782741E-05) * X)
F = +5.1513666E+00 SIGNIFICANCE OF F = SIGNIFICANT σr = +1.8111659E-02
A = -2.1528007E-01 SIGNIFICANCE OF A = SIGNIFICANT Sa = +4.2641913E-05
t = +2.2696622E+00 SIGNIFICANCE OF t = SIGNIFICANT St = +1.7770217E-02
N = 108 DEGREES OF FREEDOM = 106
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = 77 DEG/F AMB-RH
PARAMETER = STRAIN AT RUPTURE
UNIT OF MEASURE = IN/IN
0.40
0.36
0.32
0.28
0.24
0.20
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISSECTED MOTOR=STM-012,LOW RATE CHS=2.0 IN/MIN,STRAIN AT RUPTURE

Figure 3-C

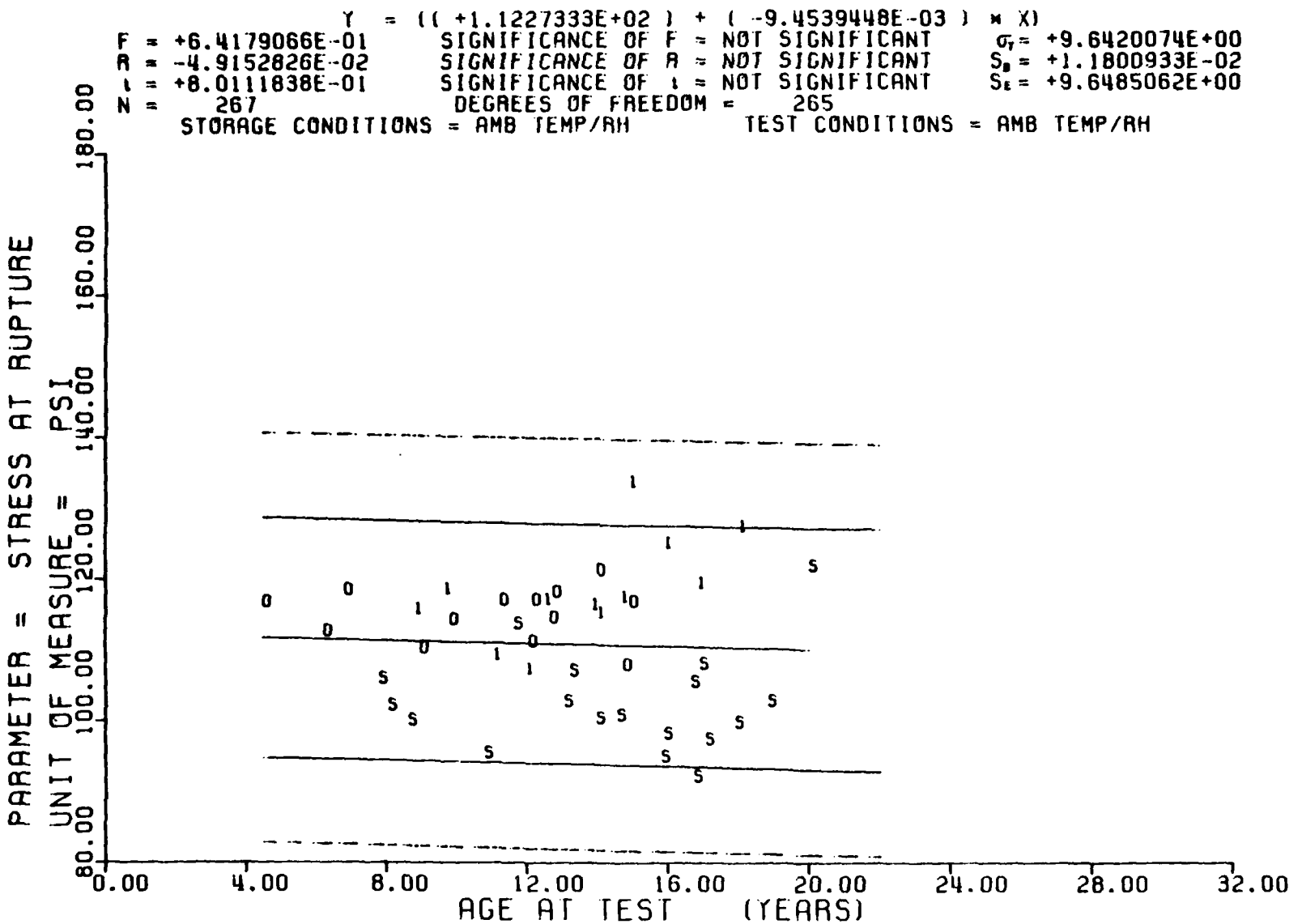
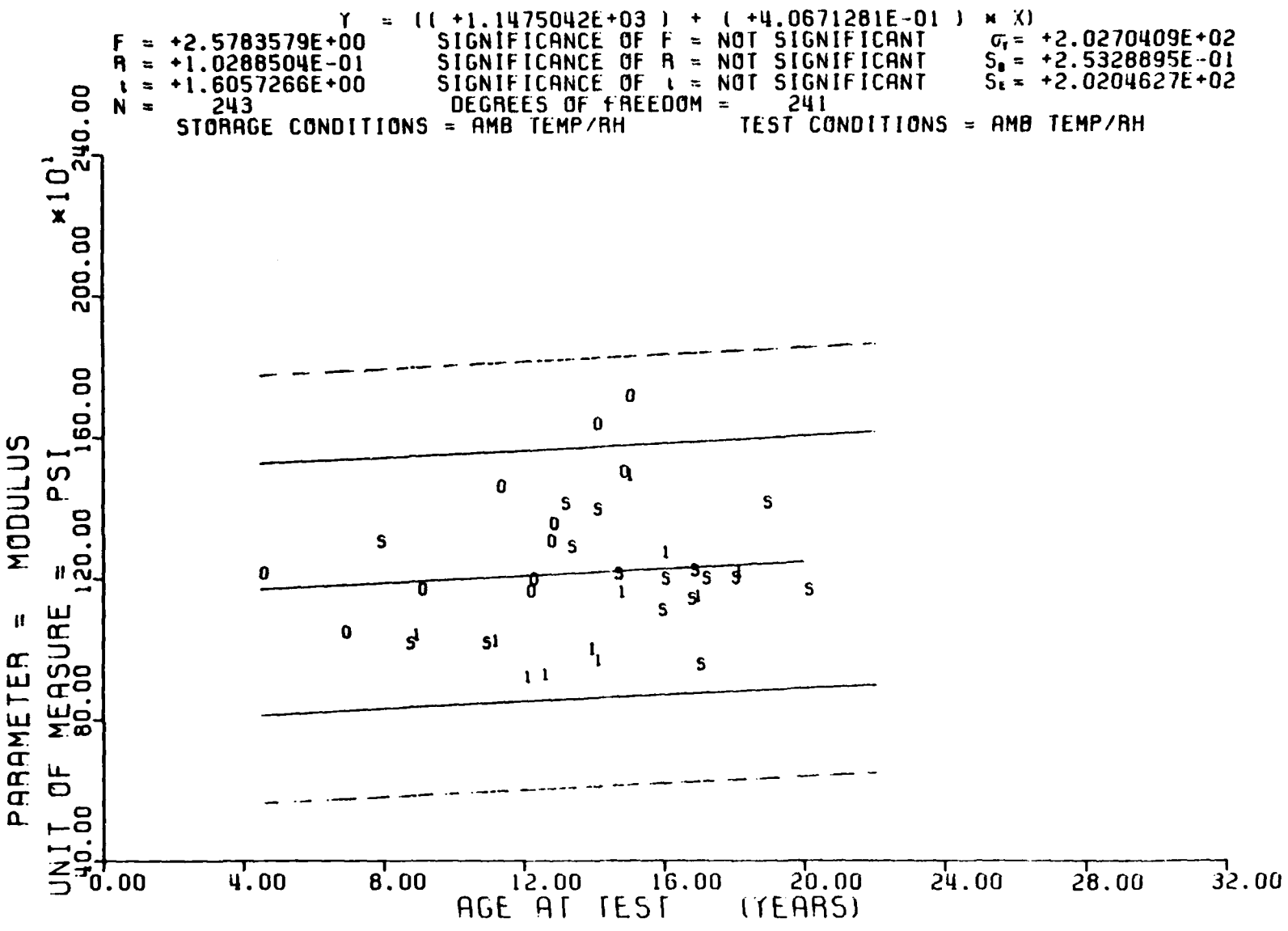

Y = ((+1.1227333E+02) + (-9.4539448E-03) * X)
F = +6.4179066E-01 SIGNIFICANCE OF F = NOT SIGNIFICANT σY = +9.6420074E+00
R = -4.9152826E-02 SIGNIFICANCE OF R = NOT SIGNIFICANT Sb = +1.1800933E-02
t = +8.0111838E-01 SIGNIFICANCE OF t = NOT SIGNIFICANT Se = +9.6485062E+00
N = 267 DEGREES OF FREEDOM = 265
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRESS AT RUPTURE
UNIT OF MEASURE = PSI
80.00
100.00
120.00
140.00
160.00
180.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISSECTED MOTORS,LOW RATE CHS=2.0 IN/MIN,STRESS AT RUPTURE

Figure 4



STAGE I DISSECTED MOTORS, LOW RATE CHS-2.0 IN/MIN, MODULUS

Figure 5

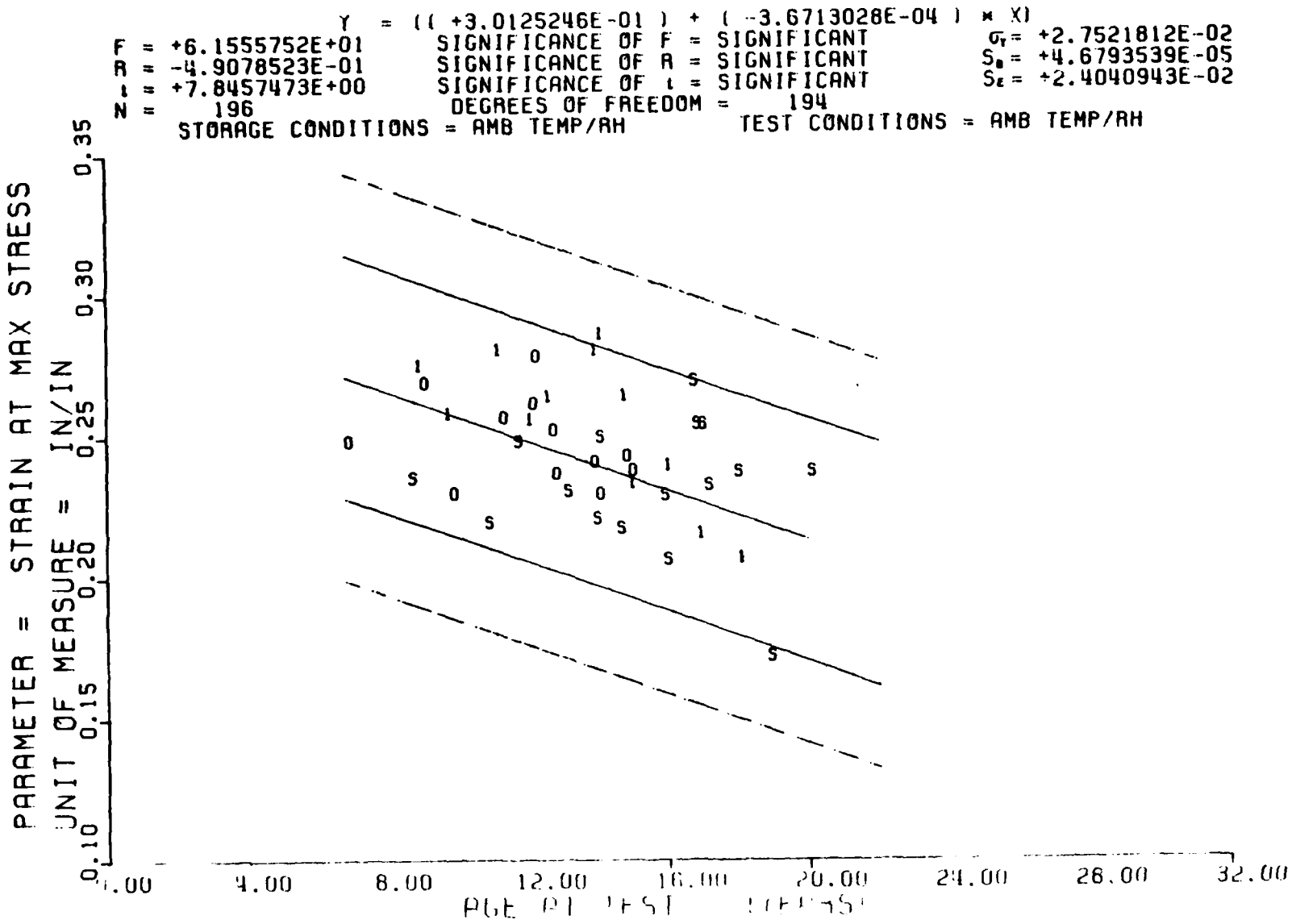

Y = ((+3.0125246E-01) + (-3.6713028E-04) * X)
F = +6.1555752E+01
R = -4.9078523E-01
t = +7.8457473E+00
N = 196
SIGNIFICANCE OF F = SIGNIFICANT
SIGNIFICANCE OF R = SIGNIFICANT
SIGNIFICANCE OF t = SIGNIFICANT
DEGREES OF FREEDOM = 194
σY = +2.7521812E-02
Sa = +4.6793539E-05
Sε = +2.4040943E-02
STORAGE CONDITIONS = AMB TEMP/RH
TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRAIN AT MAX STRESS
UNIT OF MEASURE = IN/IN
0.10
0.15
0.20
0.25
0.30
0.35
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
STAGE 1 DISSECTED MOTORS,LOW RATE CHS=20.0 IN/MIN,STRAIN MAX STRESS

Figure 6

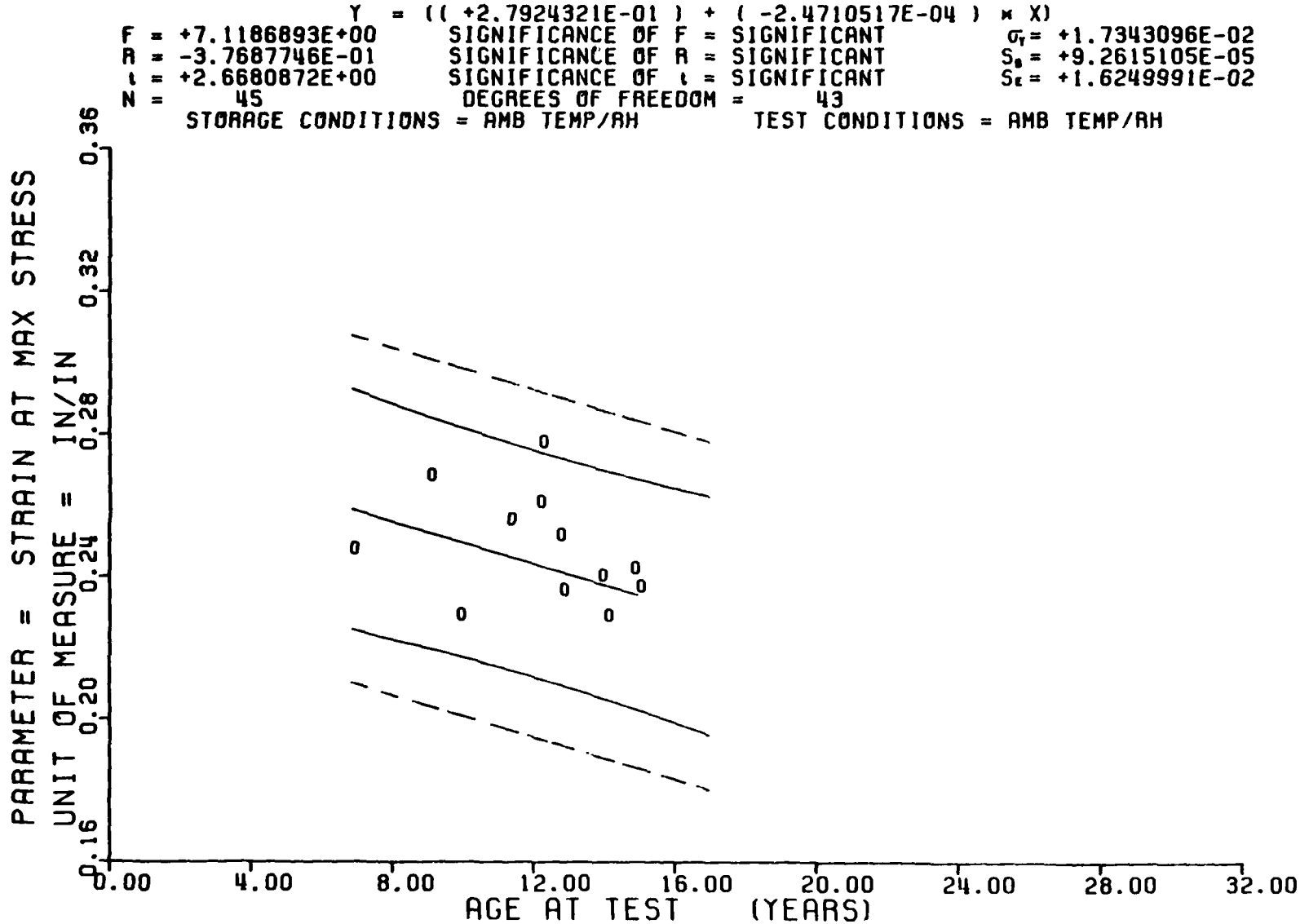

Y = ((+2.7924321E-01) + (-2.4710517E-04) * X)
F = +7.1186893E+00 SIGNIFICANCE OF F = SIGNIFICANT σr = +1.7343096E-02
R = -3.7687746E-01 SIGNIFICANCE OF R = SIGNIFICANT Sb = +9.2615105E-05
t = +2.6680872E+00 SIGNIFICANCE OF t = SIGNIFICANT St = +1.6249991E-02
N = 45 DEGREES OF FREEDOM = 43
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRAIN AT MAX STRESS
UNIT OF MEASURE = IN/IN
0.36
0.32
0.28
0.24
0.20
0.16
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISSECTED MOTOR=0012099,LOW RATE CHS=20.0 IN/MIN,STRAIN MAX STRESS

Figure 6-A

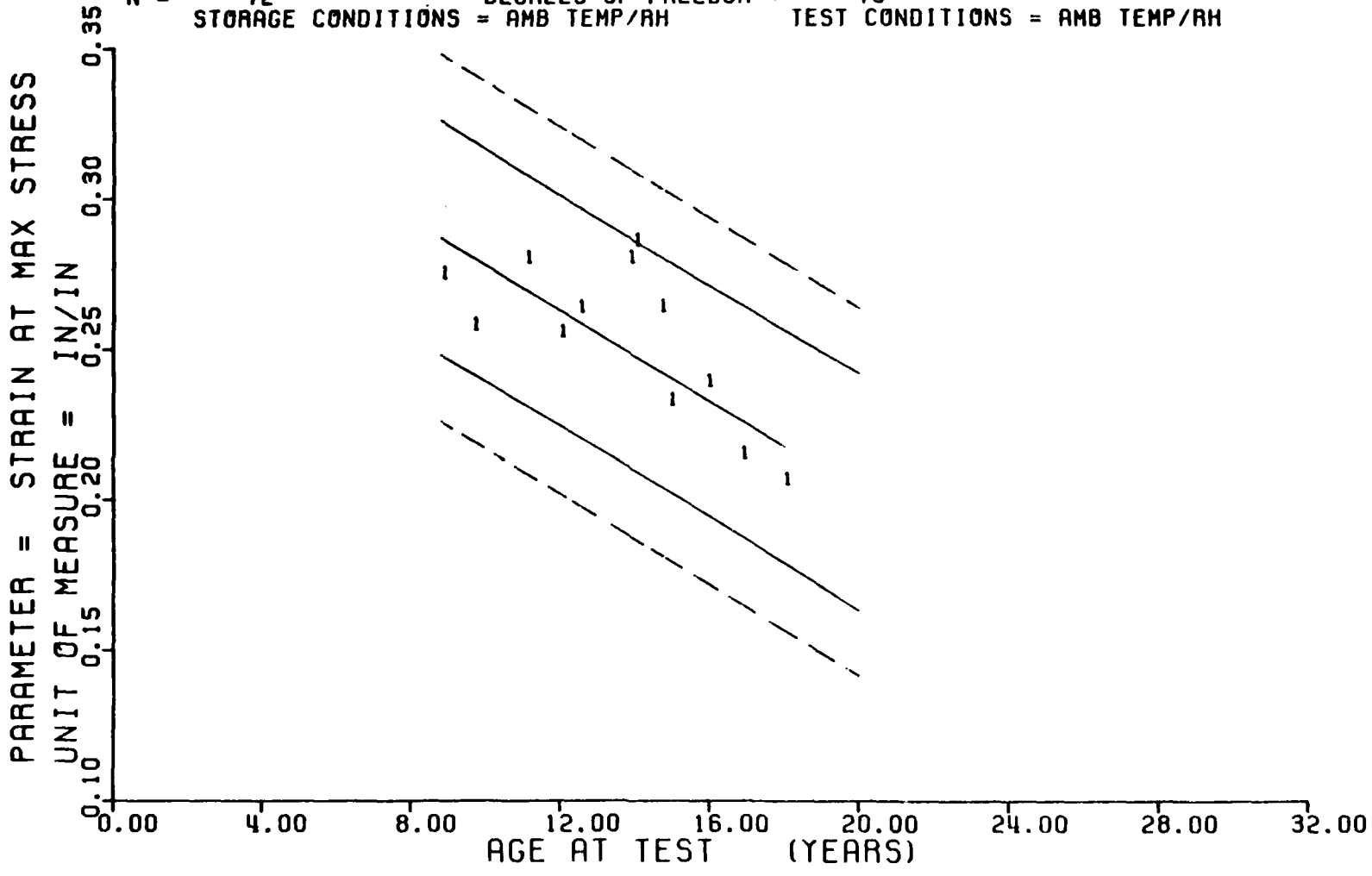

Y = ((+3.5350474E-01) + (-6.2914697E-04) * X)
F = +7.7510832E+01 SIGNIFICANCE OF F = SIGNIFICANT σY = +2.9307010E-02
R = -7.2488521E-01 SIGNIFICANCE OF R = SIGNIFICANT Sb = +7.1461300E-05
t = +8.8040236E+00 SIGNIFICANCE OF t = SIGNIFICANT Se = +2.0332404E-02
N = 72 DEGREES OF FREEDOM = 70
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRAIN AT MAX STRESS
UNIT OF MEASURE = IN/IN
0.10
0.15
0.20
0.25
0.30
0.35
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISSECTED MOTOR=0012199,LOW RATE CHS=20.0 IN/MIN,STRAIN MAX STRESS

Figure 6-B

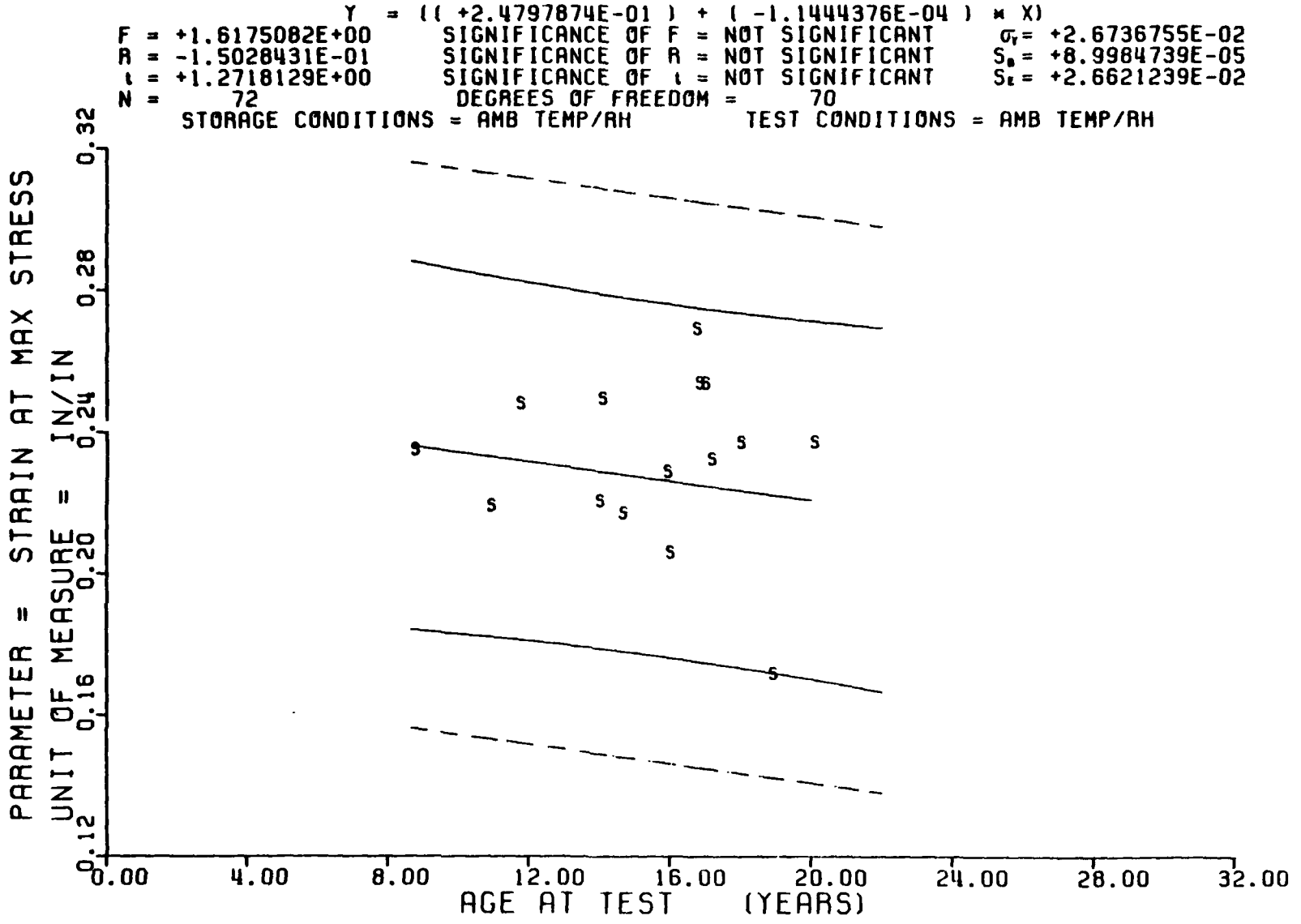

Y = ((+2.4797874E-01) + (-1.1444376E-04) * X)
F = +1.6175082E+00 SIGNIFICANCE OF F = NOT SIGNIFICANT σr = +2.6736755E-02
R = -1.5028431E-01 SIGNIFICANCE OF R = NOT SIGNIFICANT Sb = +8.9984739E-05
t = +1.2718129E+00 SIGNIFICANCE OF t = NOT SIGNIFICANT St = +2.6621239E-02
N = 72 DEGREES OF FREEDOM = 70
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRAIN AT MAX STRESS
UNIT OF MEASURE = IN/IN
0.32
0.28
0.24
0.20
0.16
0.12
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISSECTED MOTOR=STM-012,LOW RATE CHS=20.0 IN/MIN,STRAIN MAX STRESS

Figure 6-C

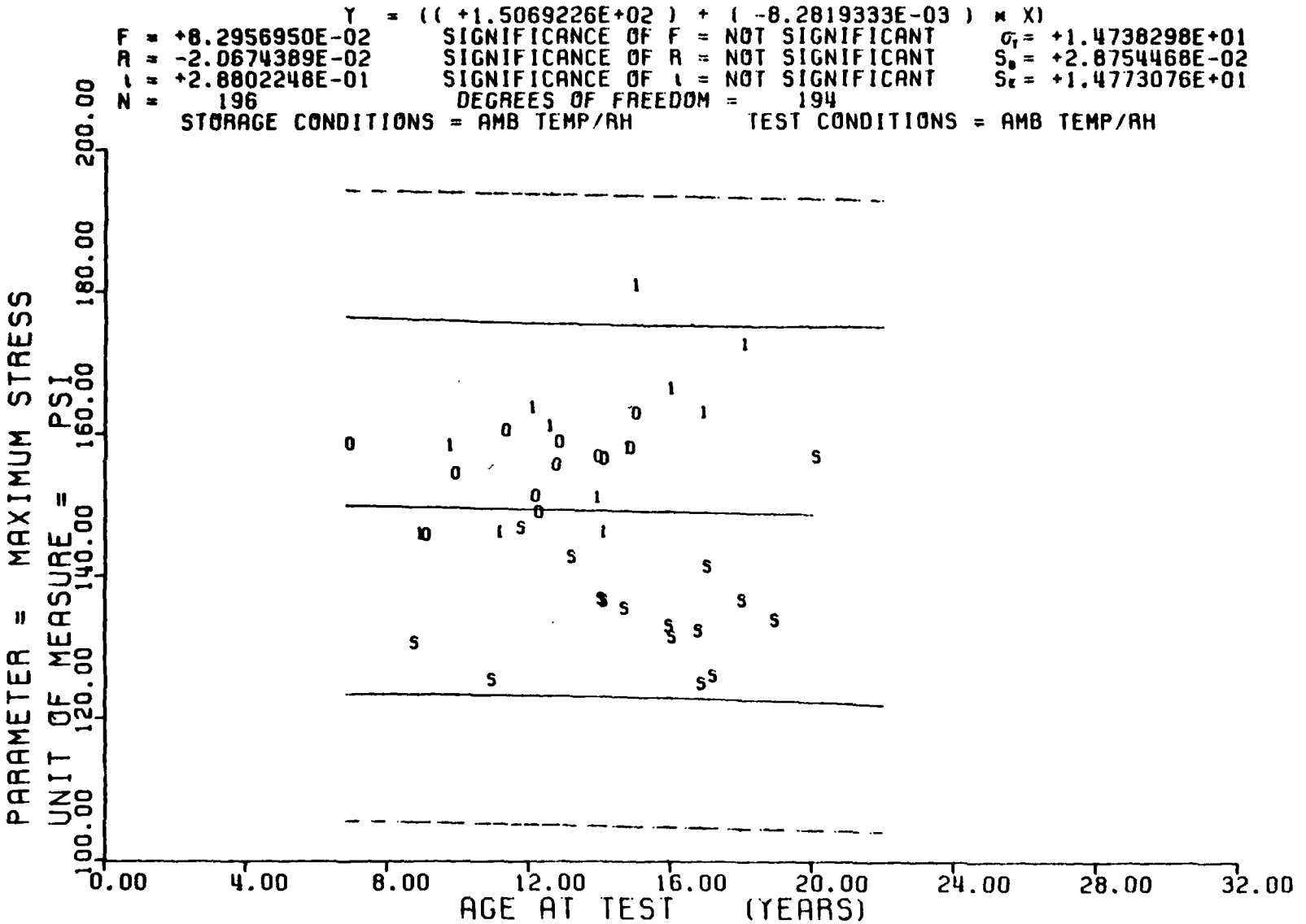
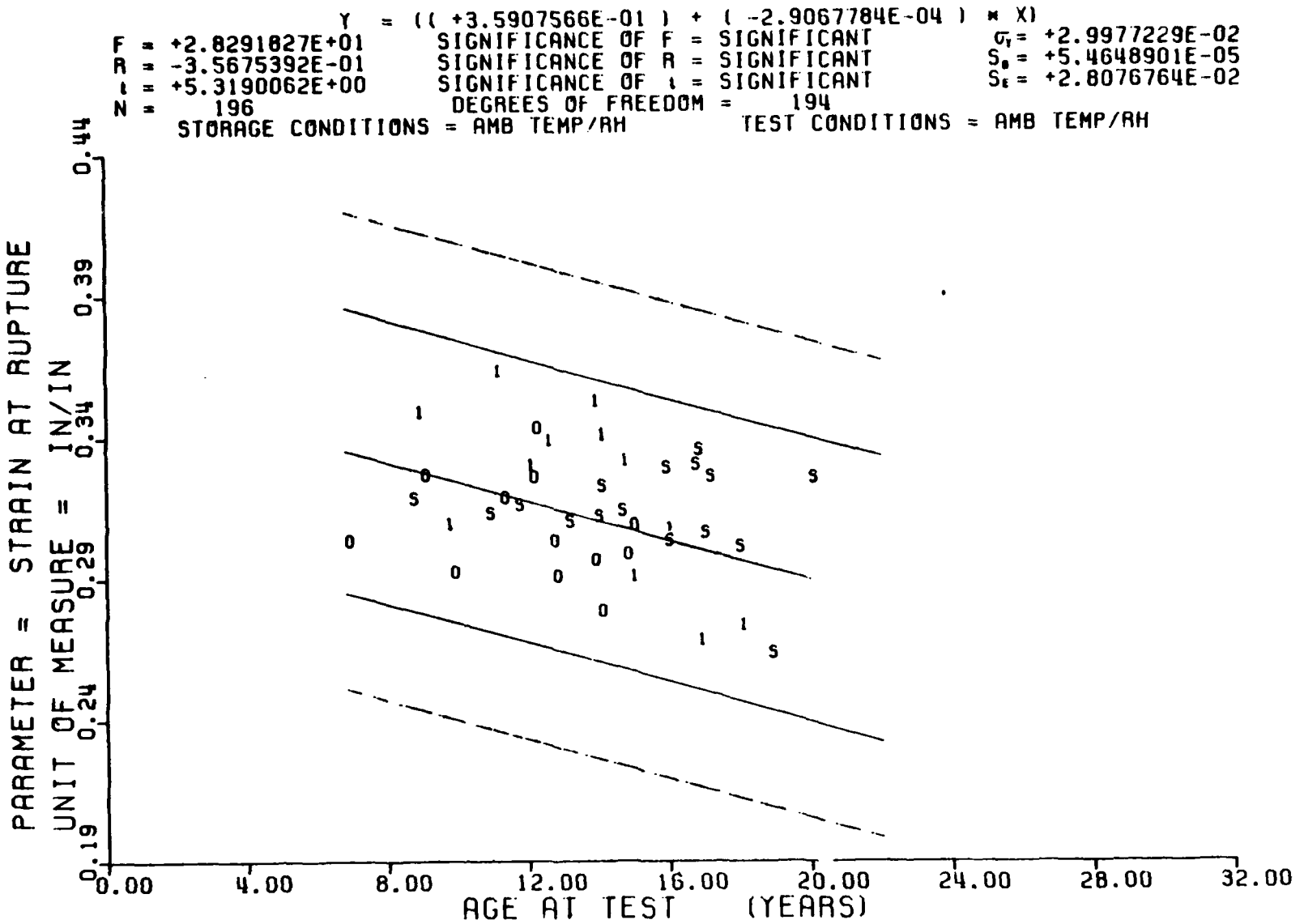

Y = ((+1.5069226E+02) + (-8.2819333E-03) * X)
F = +8.2956950E-02 SIGNIFICANCE OF F = NOT SIGNIFICANT σT = +1.4738298E+01
R = -2.0674389E-02 SIGNIFICANCE OF R = NOT SIGNIFICANT Sb = +2.8754468E-02
ι = +2.8802248E-01 SIGNIFICANCE OF ι = NOT SIGNIFICANT Sε = +1.4773076E+01
N = 196 DEGREES OF FREEDOM = 194
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = MAXIMUM STRESS
UNIT OF MEASURE = PSI
100.00
120.00
140.00
160.00
180.00
200.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISSECTED MOTORS,LOW RATE CHS=20.0 IN/MIN,MAXIMUM STRESS

Figure 7



STAGE 1 DISSECTED MOTORS,LOW RATE CHS=20.0 IN/MIN,STRAIN AT RUPTURE

Figure 8

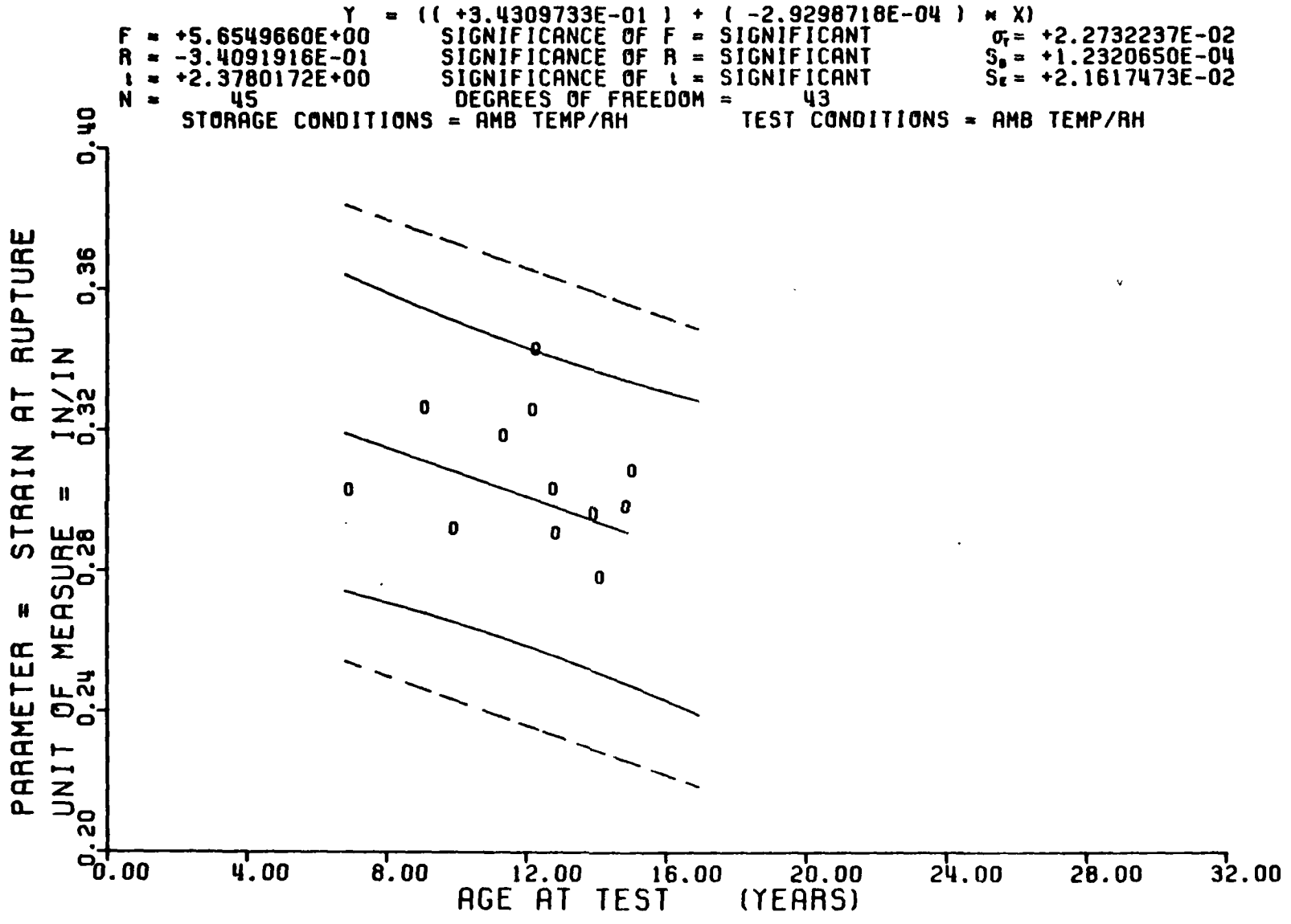

Y = ((+3.4309733E-01) + (-2.9298718E-04) * X)
F = +5.6549660E+00 SIGNIFICANCE OF F = SIGNIFICANT
R = -3.4091916E-01 SIGNIFICANCE OF R = SIGNIFICANT
t = +2.3780172E+00 SIGNIFICANCE OF t = SIGNIFICANT
N = 45 DEGREES OF FREEDOM = 43
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRAIN AT RUPTURE
UNIT OF MEASURE = IN/IN
0.40
0.36
0.32
0.28
0.24
0.20
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISSECTED MOTOR=0012099,LOW RATE CHS=20.0 IN/MIN,STRAIN AT RUPTURE

Figure 8-A

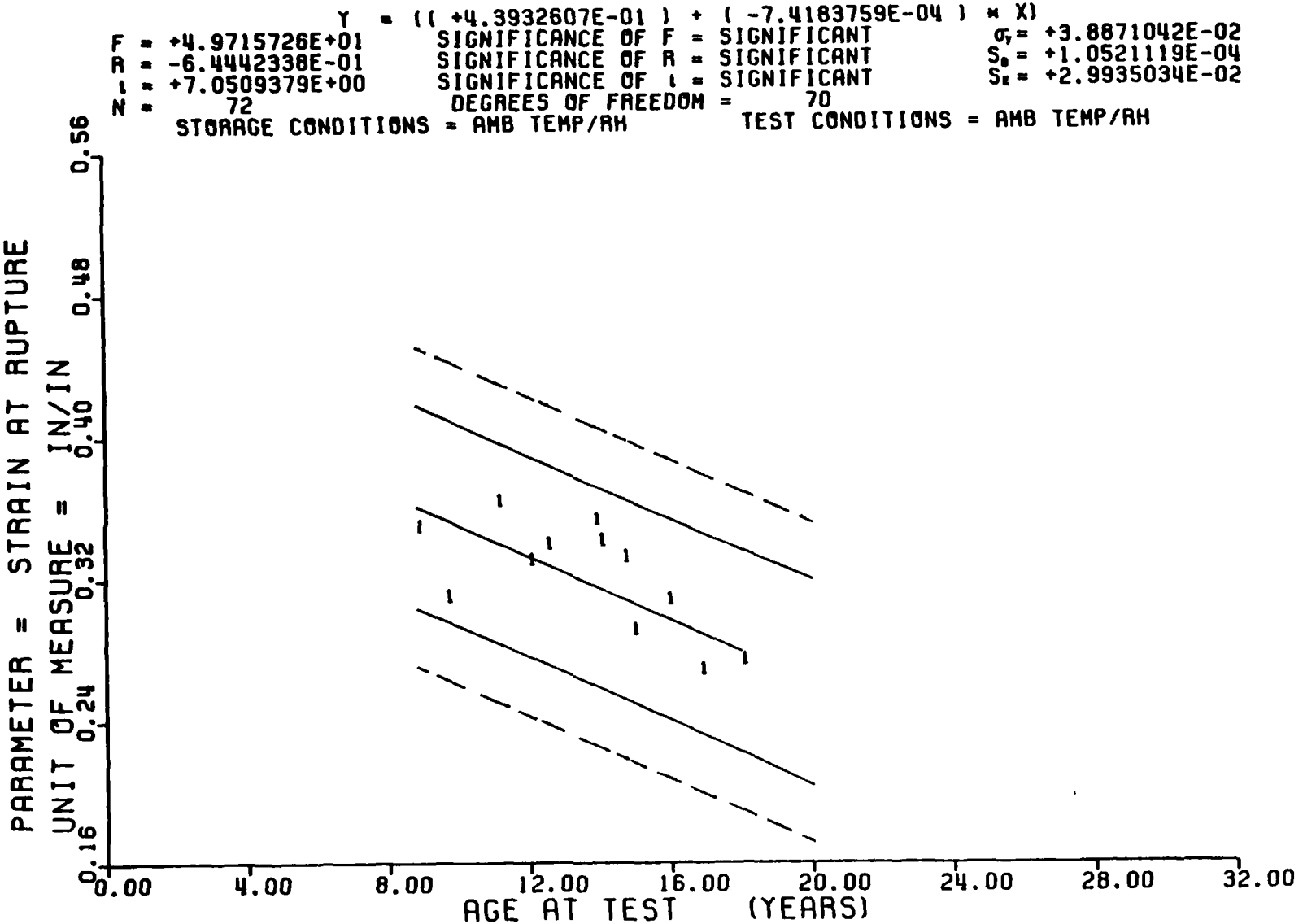

Y = ((+4.3932607E-01) + (-7.4183759E-04) * X)
F = +4.9715726E+01
R = -6.4442338E-01
t = +7.0509379E+00
N = 72
SIGNIFICANCE OF F = SIGNIFICANT
SIGNIFICANCE OF R = SIGNIFICANT
SIGNIFICANCE OF t = SIGNIFICANT
DEGREES OF FREEDOM = 70
σy = +3.8871042E-02
Sb = +1.0521119E-04
Sε = +2.9935034E-02
STORAGE CONDITIONS = AMB TEMP/RH
TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRAIN AT RUPTURE
UNIT OF MEASURE = IN/IN
0.56
0.48
0.40
0.32
0.24
0.16
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISSECTED MOTOR=0012199,LOW RATE CHS=20.0 IN/MIN,STRAIN AT RUPTURE

Figure 8-B

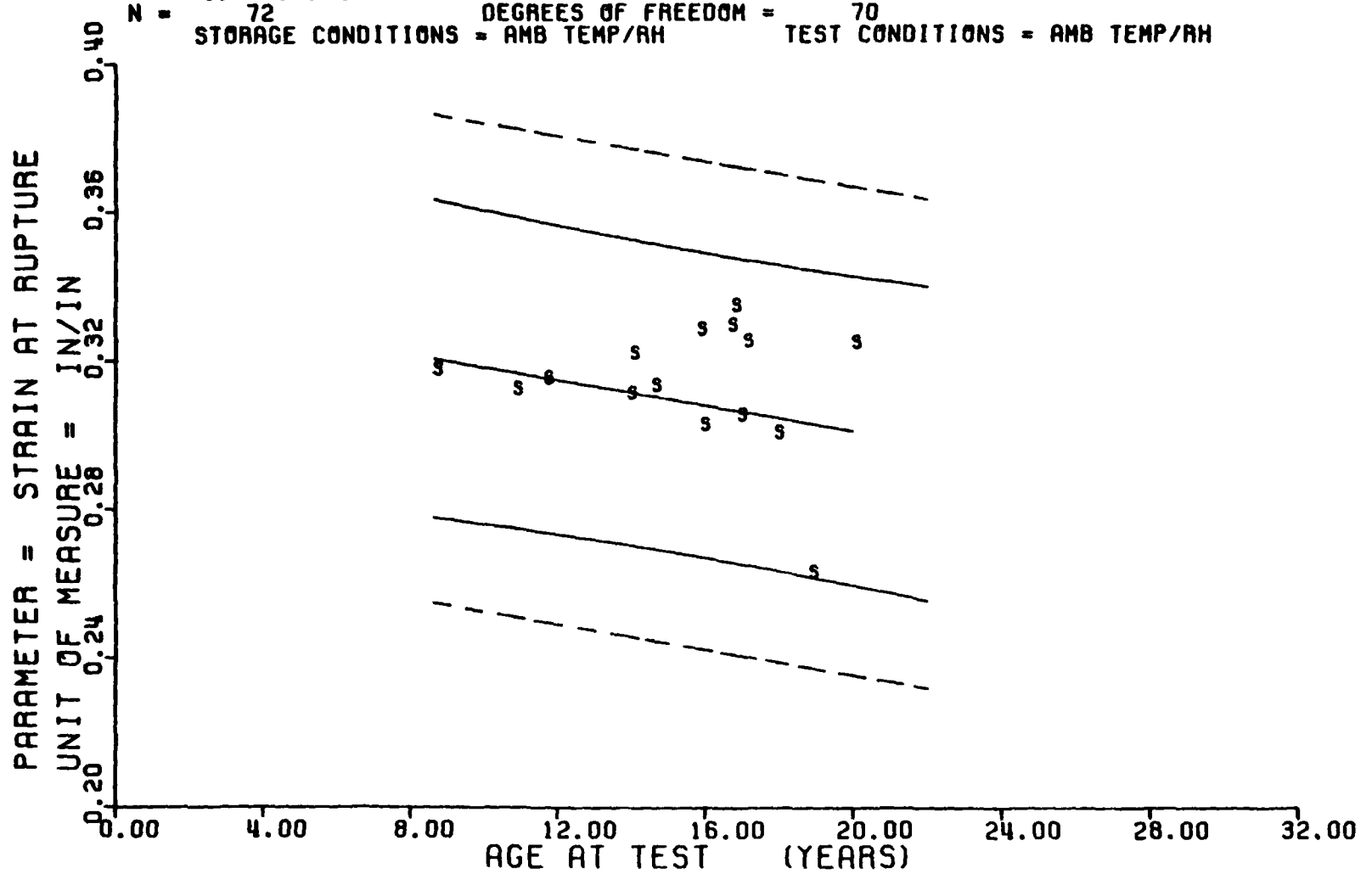

Y = ((+3.3567674E-01) + (-1.4385363E-04) * X)
F = +3.7783972E+00 SIGNIFICANCE OF F = NOT SIGNIFICANT σr = +2.2318339E-02
R = -2.2630242E-01 SIGNIFICANCE OF R = NOT SIGNIFICANT Sb = +7.4006018E-05
t = +1.9438099E+00 SIGNIFICANCE OF t = NOT SIGNIFICANT Se = +2.1894067E-02
N = 72 DEGREES OF FREEDOM = 70
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRAIN AT RUPTURE
UNIT OF MEASURE = IN/IN
0.40
0.36
0.32
0.28
0.24
0.20
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISSECTED MOTOR=STM-012,LOW RATE CHS=20.0 IN/MIN,STRAIN AT RUPTURE

Figure 8-C

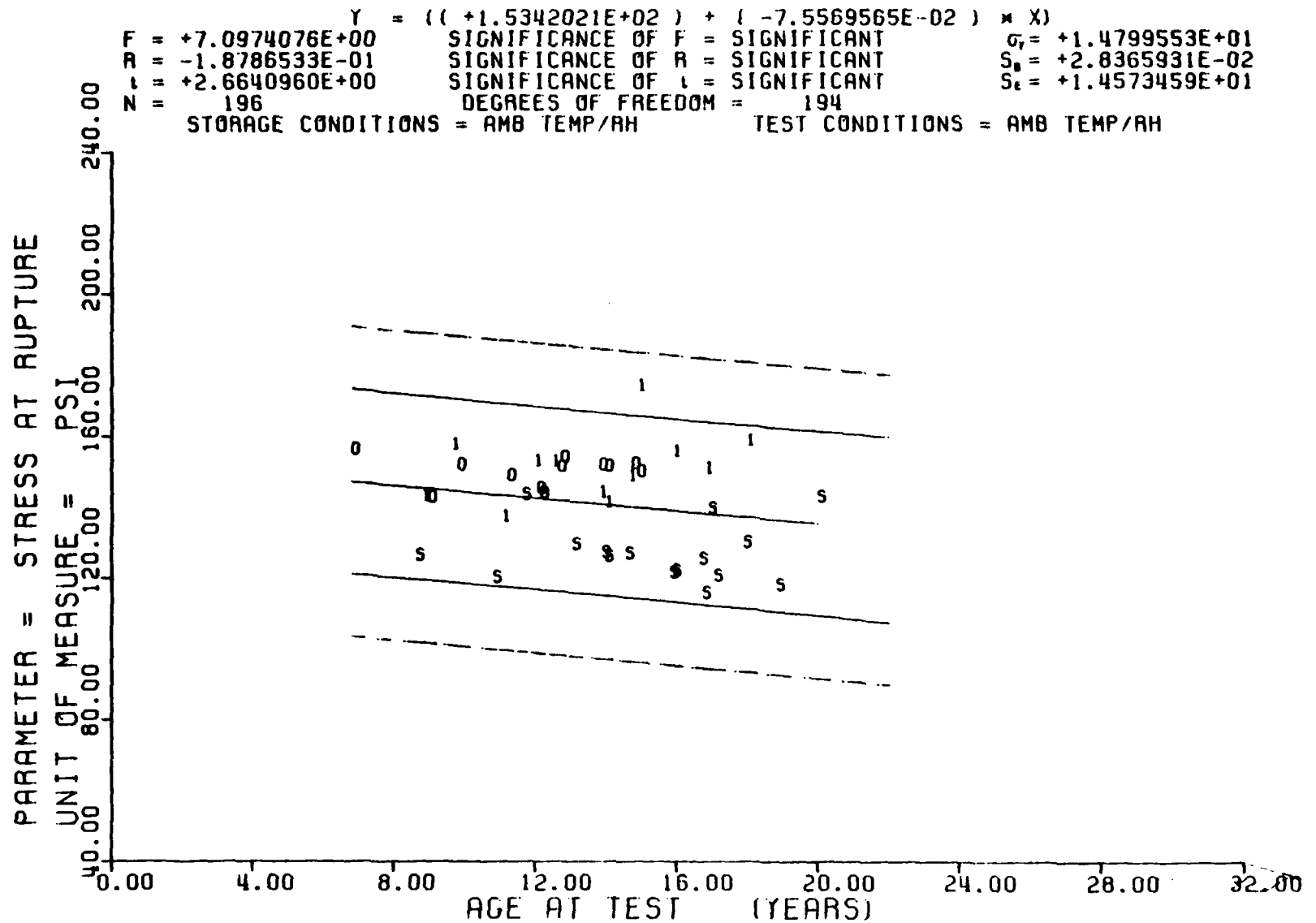

Y = ((+1.5342021E+02) + (-7.5569565E-02) * X)
F = +7.0974076E+00 SIGNIFICANCE OF F = SIGNIFICANT σr = +1.4799553E+01
R = -1.8786533E-01 SIGNIFICANCE OF R = SIGNIFICANT Sb = +2.8365931E-02
t = +2.6640960E+00 SIGNIFICANCE OF t = SIGNIFICANT Se = +1.4573459E+01
N = 196 DEGREES OF FREEDOM = 194
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRESS AT RUPTURE
UNIT OF MEASURE = PSI
240.00
200.00
160.00
120.00
80.00
40.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISSECTED MOTORS,LOW RATE CHS=20.0 IN/MIN,STRESS AT RUPTURE

Figure 9

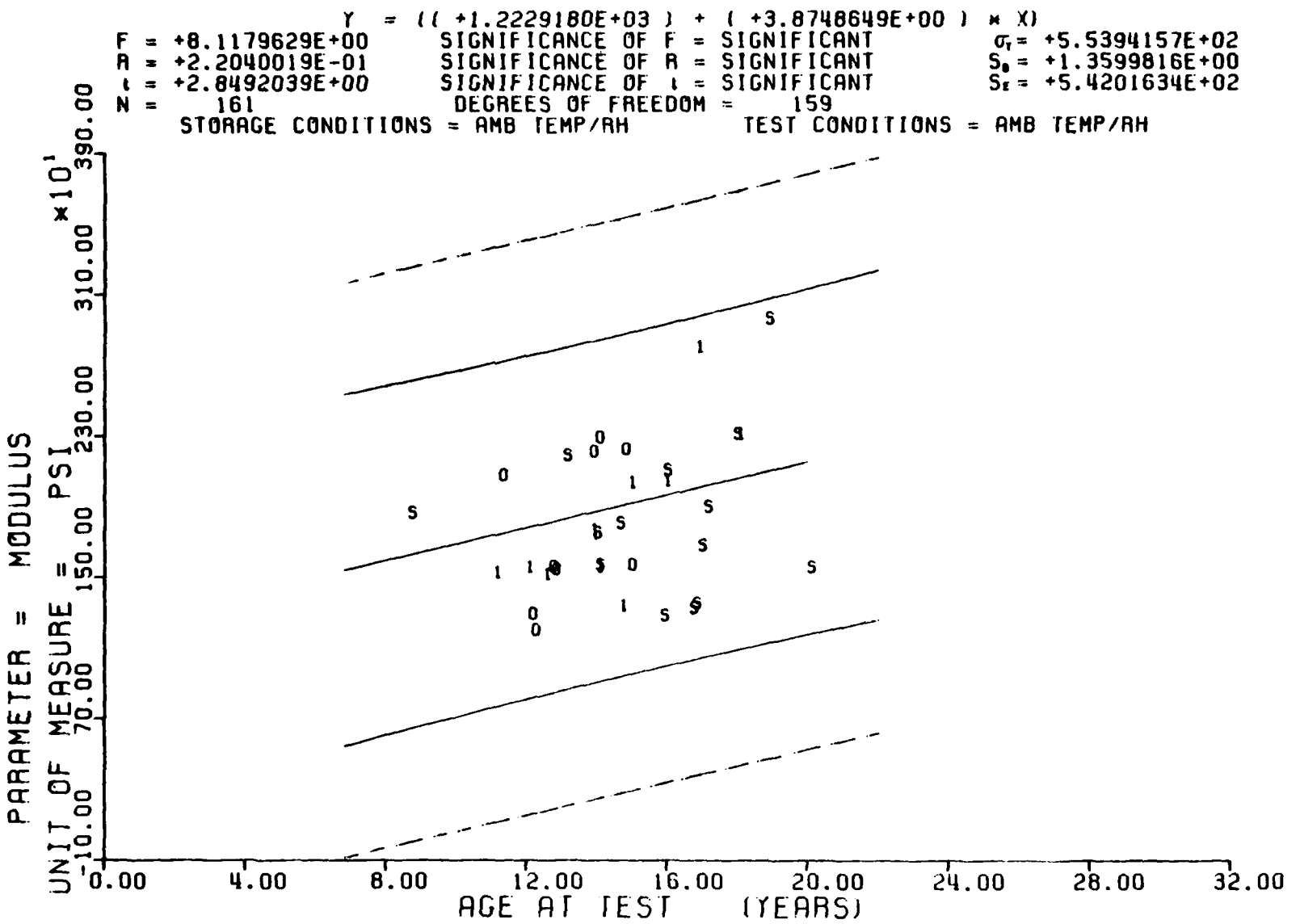
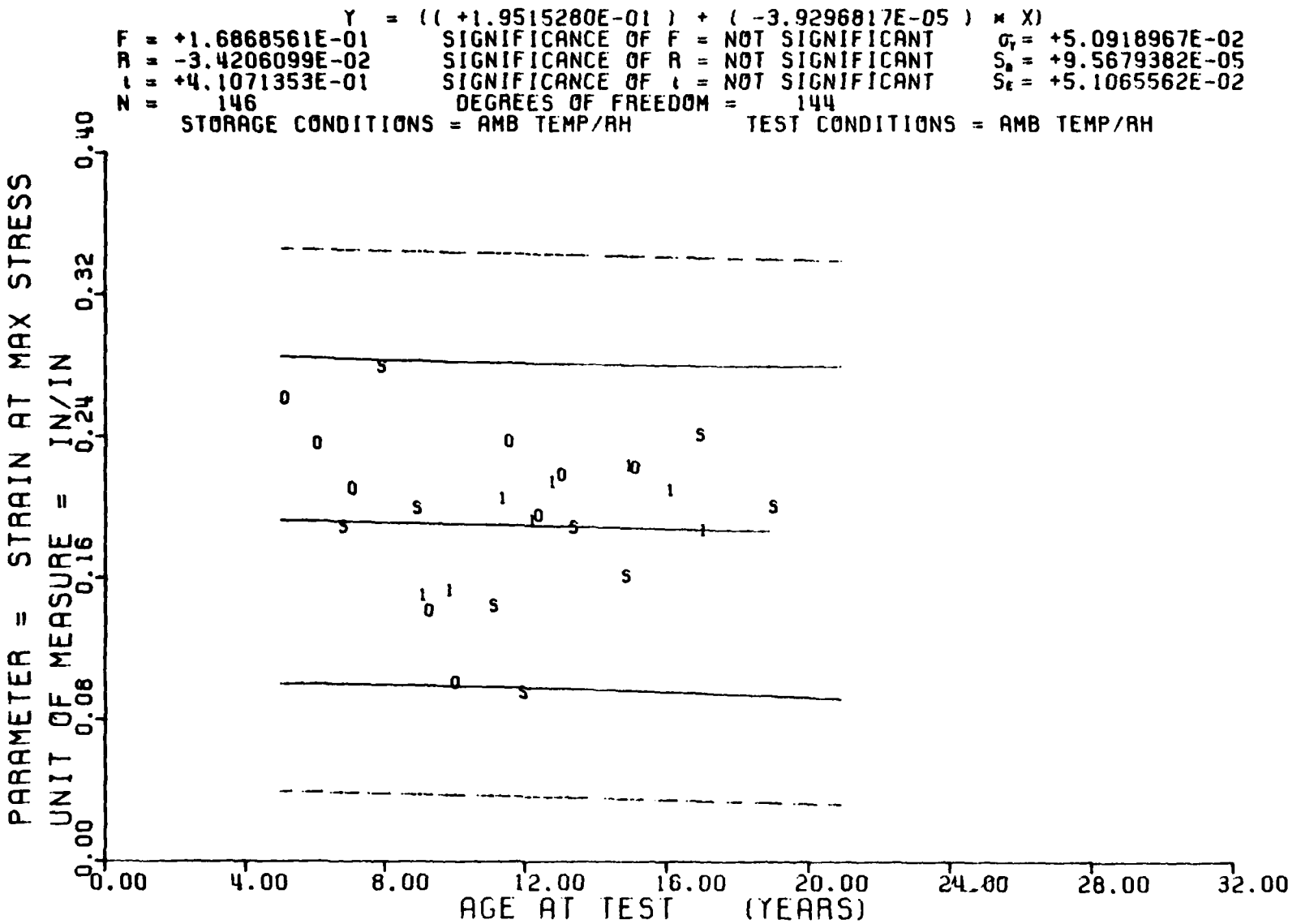

Y = ((+1.2229180E+03) + (+3.8748649E+00) * X)
F = +8.1179629E+00 SIGNIFICANCE OF F = SIGNIFICANT
R = +2.2040019E-01 SIGNIFICANCE OF R = SIGNIFICANT
t = +2.8492039E+00 SIGNIFICANCE OF t = SIGNIFICANT
N = 161 DEGREES OF FREEDOM = 159
STORAGE CONDITIONS = AMB TEMP/RH
TEST CONDITIONS = AMB TEMP/RH
σT = +5.5394157E+02
Se = +1.3599816E+00
Sr = +5.4201634E+02
PARAMETER = MODULUS
UNIT OF MEASURE = PSI
×10¹
390.00
310.00
230.00
150.00
70.00
-10.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISSECTED MOTORS,LOW RATE CHS=20.0 IN/MIN,MODULUS

Figure 10



STAGE 1 DISSECTED MOTORS,HIGH RATE CHS=1750 IN/MIN,STRAIN MAX STRESS

Figure 11

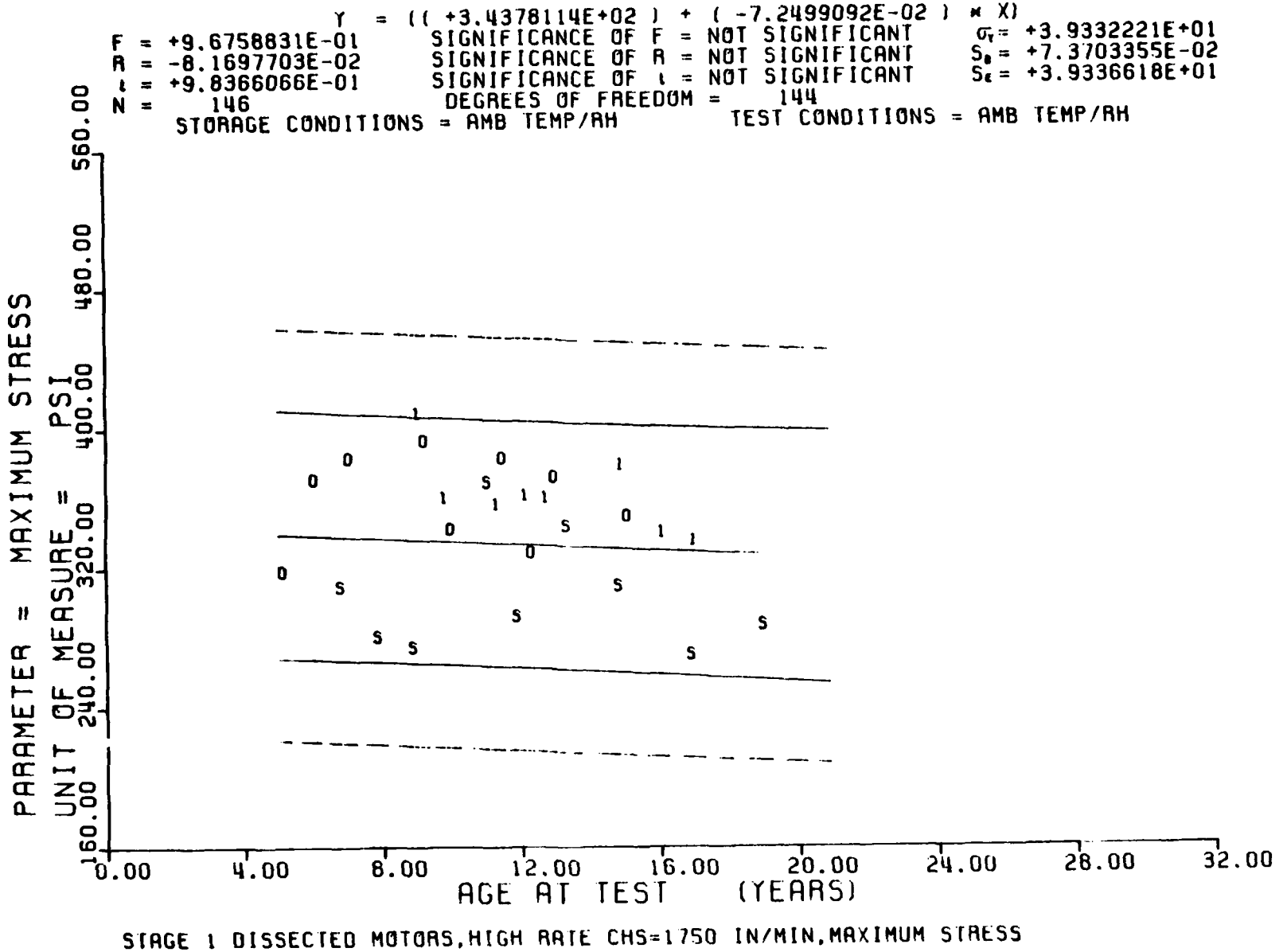
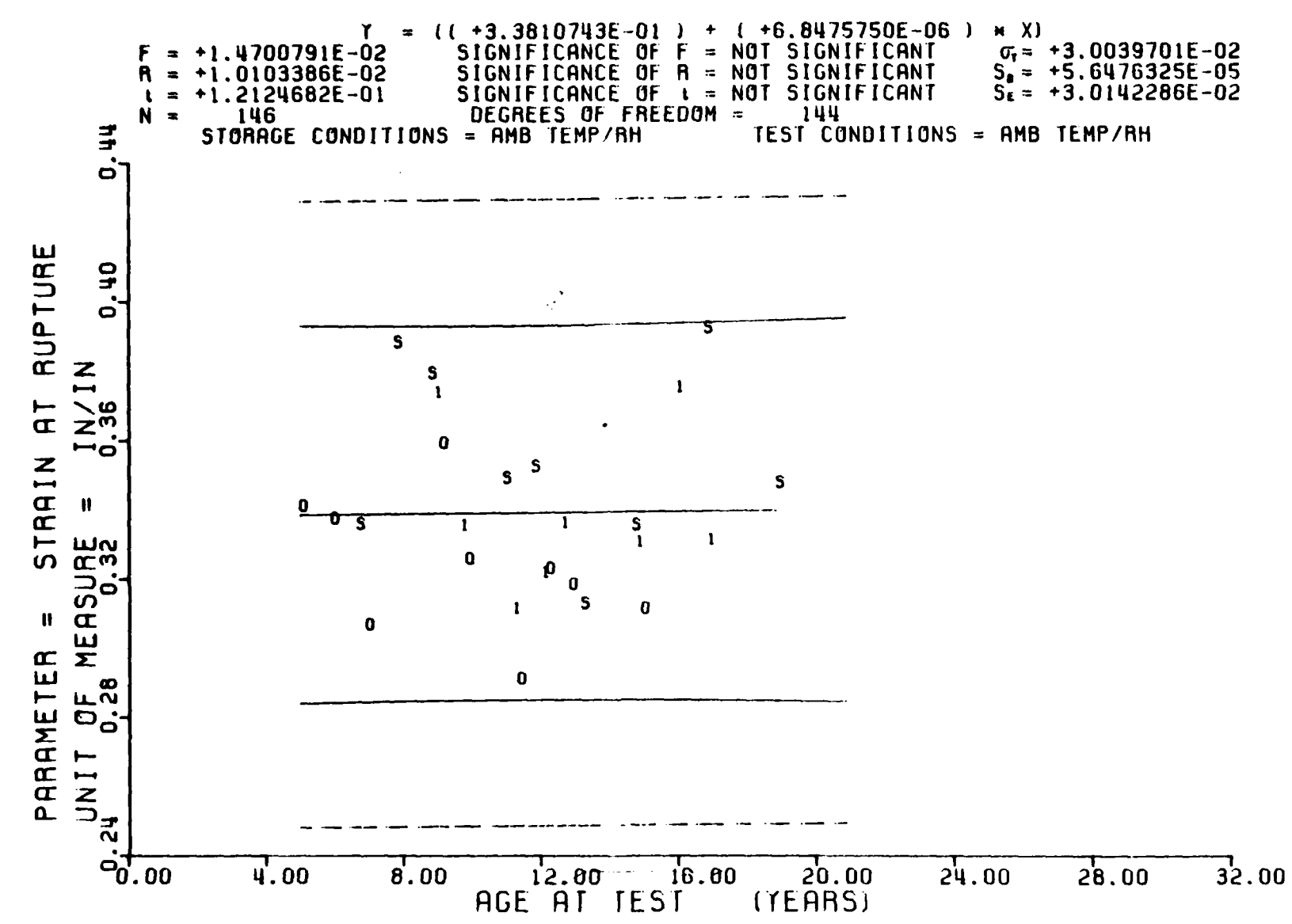

Y = ((+3.4378114E+02) + (-7.2499092E-02) * X)
F = +9.6758831E-01 SIGNIFICANCE OF F = NOT SIGNIFICANT σY = +3.9332221E+01
R = -8.1697703E-02 SIGNIFICANCE OF R = NOT SIGNIFICANT Sβ = +7.3703355E-02
r = +9.8366066E-01 SIGNIFICANCE OF r = NOT SIGNIFICANT Sε = +3.9336618E+01
N = 146 DEGREES OF FREEDOM = 144
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = MAXIMUM STRESS
UNIT OF MEASURE = PSI
560.00
480.00
400.00
320.00
240.00
160.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISSECTED MOTORS,HIGH RATE CHS=1750 IN/MIN,MAXIMUM STRESS

Figure 12



STAGE 1 DISSECTED MOTORS, HIGH RATE CHS=1750 IN/MIN, STRAIN AT RUPTURE

Figure 13

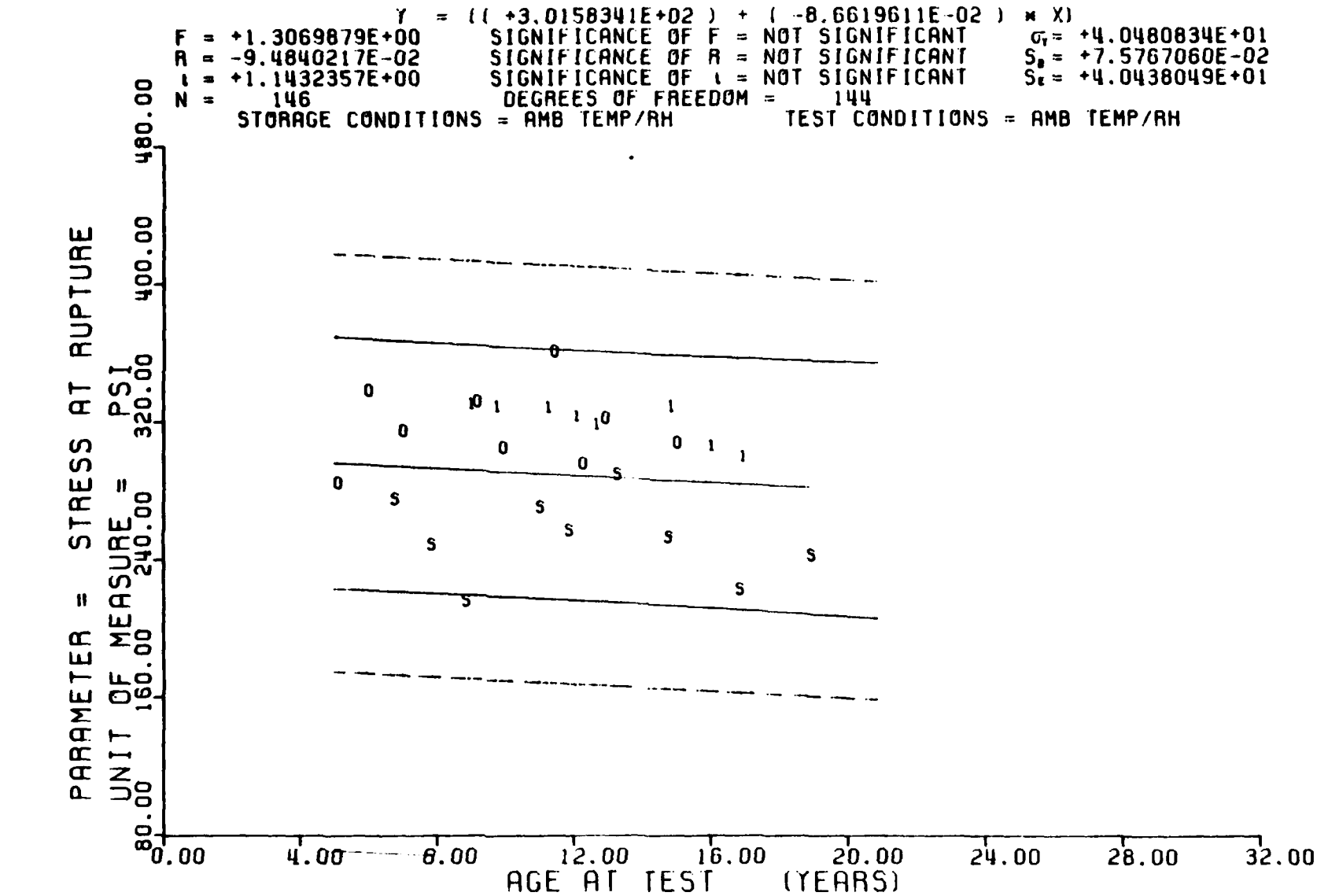
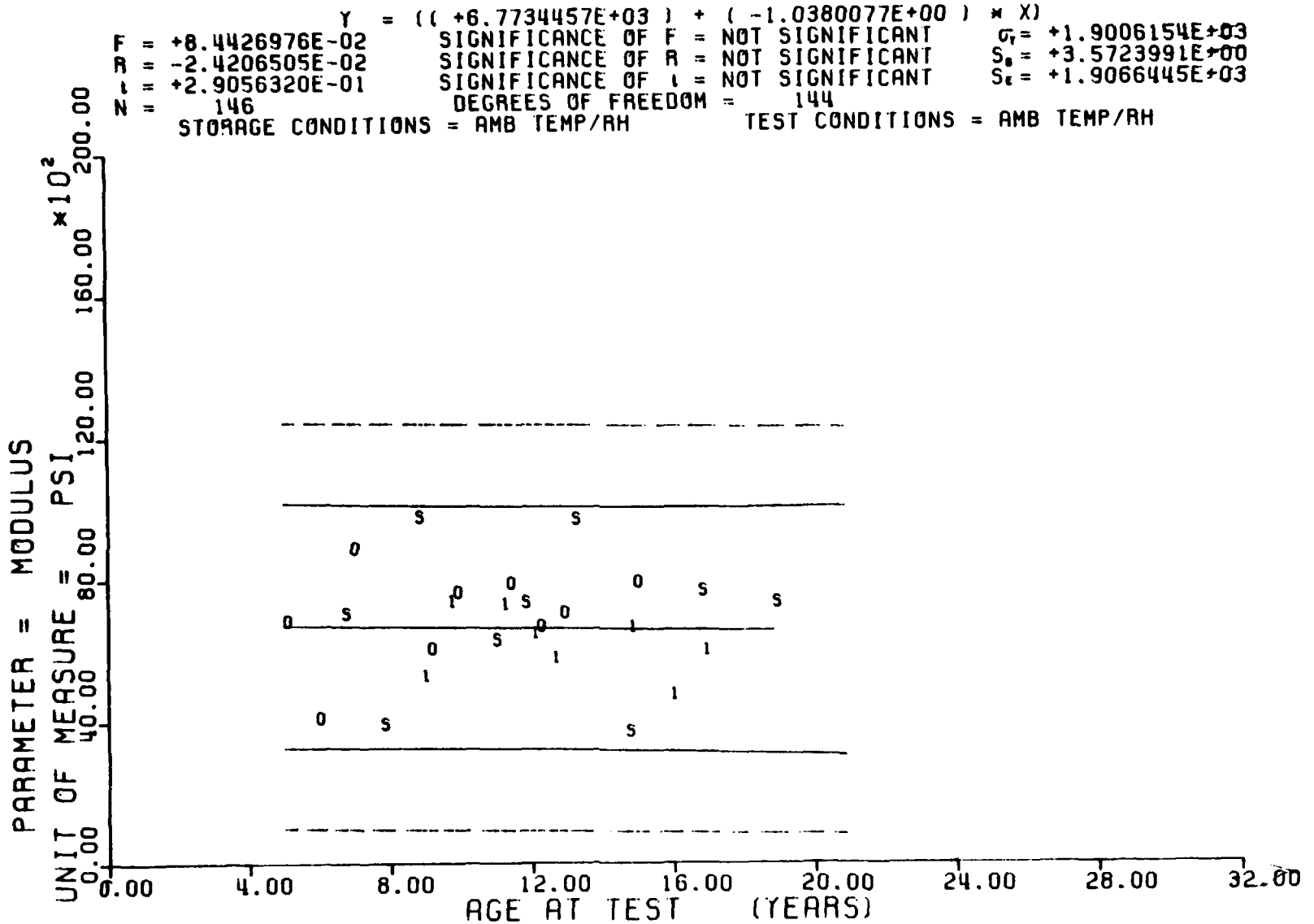

Y = ((+3.0158341E+02) + (-8.6619611E-02) * X)
F = +1.3069879E+00 SIGNIFICANCE OF F = NOT SIGNIFICANT σ1 = +4.0480834E+01
R = -9.4840217E-02 SIGNIFICANCE OF R = NOT SIGNIFICANT Sb = +7.5767060E-02
t = +1.1432357E+00 SIGNIFICANCE OF t = NOT SIGNIFICANT Se = +4.0438049E+01
N = 146 DEGREES OF FREEDOM = 144
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRESS AT RUPTURE
UNIT OF MEASURE = PSI
480.00
400.00
320.00
240.00
160.00
80.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISSECTED MOTORS,HIGH RATE CHS=1750 IN/MIN,STRESS AT RUPTURE

Figure 14



STAGE 1 DISSECTED MOTORS, HIGH RATE CHS=1750 IN/MIN, MODULUS

Figure 15

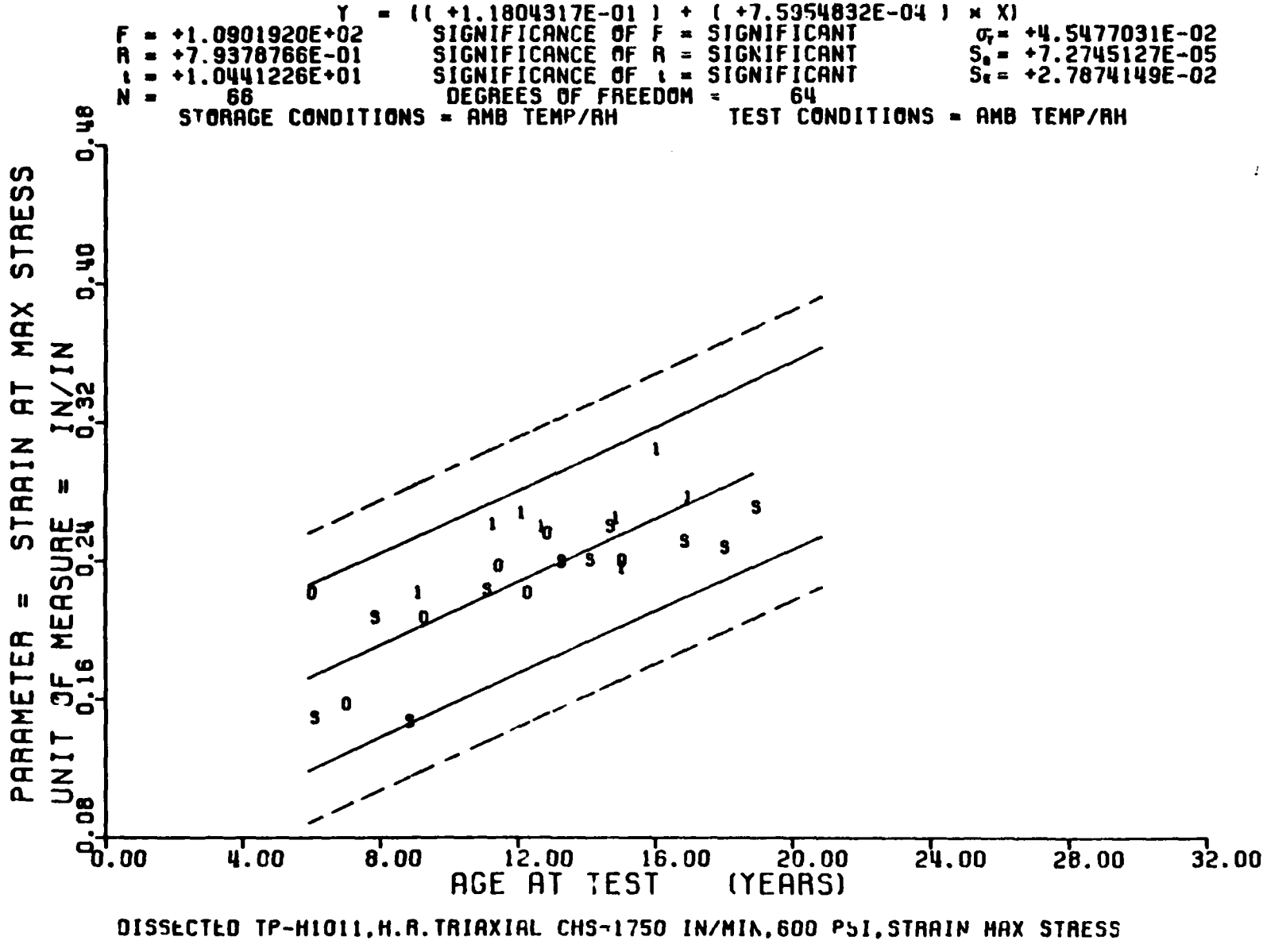

Y = ((+1.1804317E-01) + (+7.5954832E-04) × X)
F = +1.0901920E+02 SIGNIFICANCE OF F = SIGNIFICANT σr = +4.5477031E-02
R = +7.9378766E-01 SIGNIFICANCE OF R = SIGNIFICANT Sa = +7.2745127E-05
t = +1.0441226E+01 SIGNIFICANCE OF t = SIGNIFICANT Sε = +2.7874149E-02
N = 66 DEGREES OF FREEDOM = 64
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRAIN AT MAX STRESS
UNIT OF MEASURE = IN/IN
0.08
0.16
0.24
0.32
0.40
0.48
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
DISSECTED TP-H1011,H.R.TRIAXIAL CHS-1750 IN/MIN,600 PSI,STRAIN MAX STRESS

Figure 16

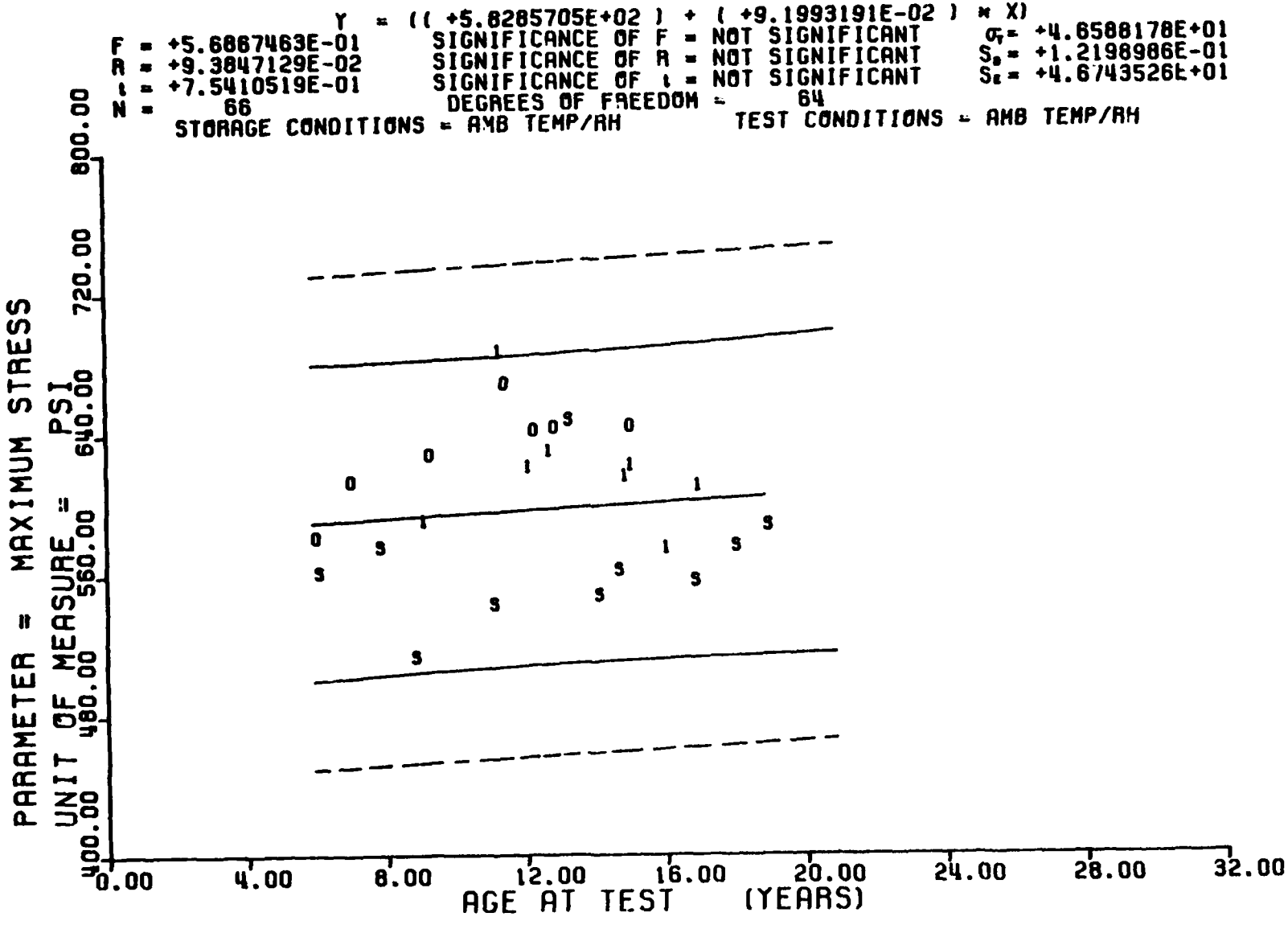

Y = ((+5.8285705E+02) + (+9.1993191E-02) * X)
F = +5.6867463E-01
R = +9.3847129E-02
t = +7.5410519E-01
N = 66
SIGNIFICANCE OF F = NOT SIGNIFICANT
SIGNIFICANCE OF R = NOT SIGNIFICANT
SIGNIFICANCE OF t = NOT SIGNIFICANT
DEGREES OF FREEDOM = 64
σT = +4.6588178E+01
Se = +1.2198986E-01
Sε = +4.6743526E+01
STORAGE CONDITIONS = AMB TEMP/RH
TEST CONDITIONS = AMB TEMP/RH
PARAMETER = MAXIMUM STRESS
UNIT OF MEASURE = PSI
400.00
480.00
560.00
640.00
720.00
800.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
DISSECTED TP-H1011,H.R.TRIAXIAL CHS=1750 IN/MIN,600 PSI,MAXIMUM STRESS

Figure 17

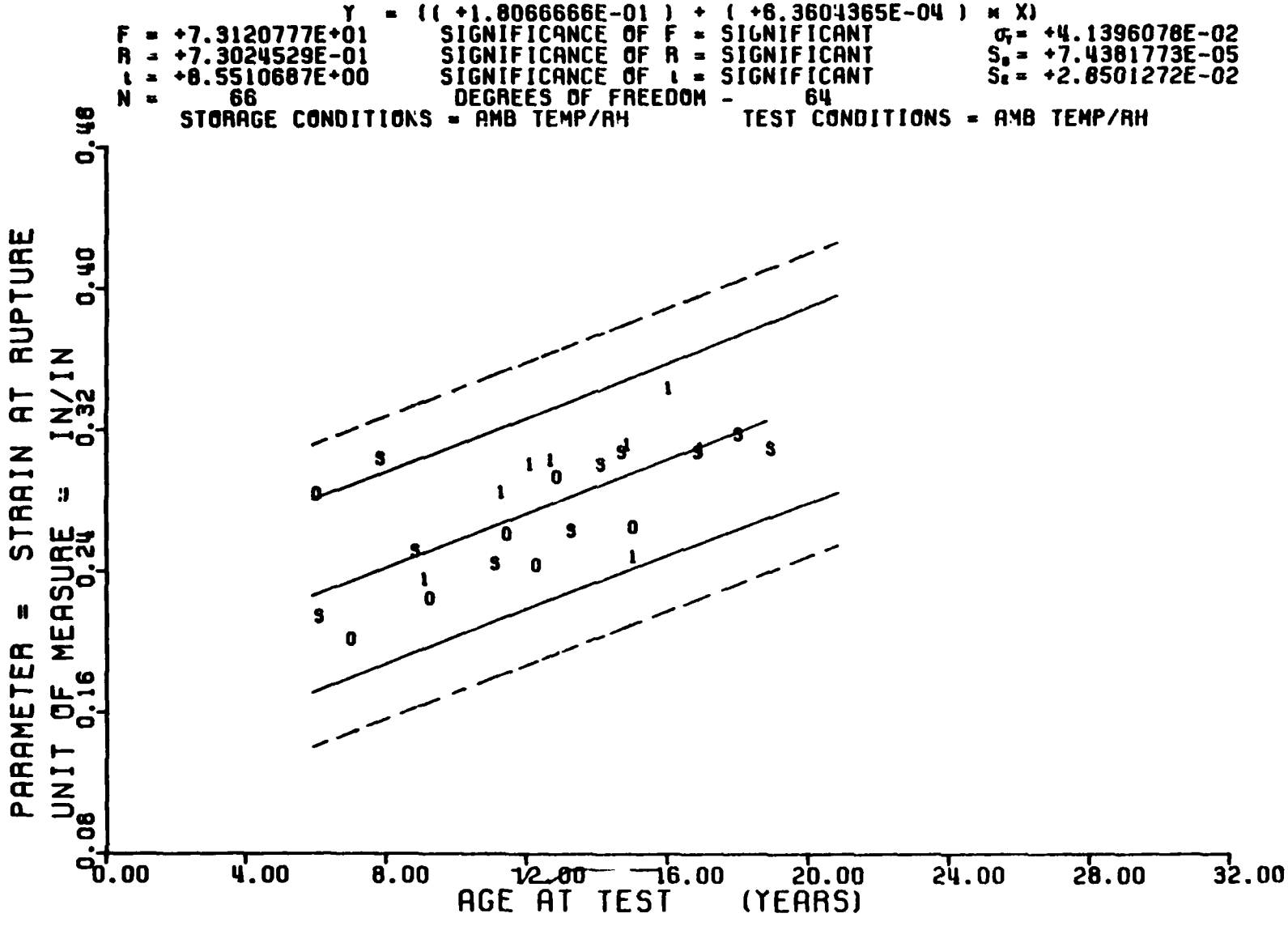

Y = ((+1.8066666E-01) + (+6.3604365E-04) * X)
F = +7.3120777E+01 SIGNIFICANCE OF F = SIGNIFICANT σr = +4.1396078E-02
R = +7.3024529E-01 SIGNIFICANCE OF R = SIGNIFICANT Sb = +7.4381773E-05
t = +8.5510687E+00 SIGNIFICANCE OF t = SIGNIFICANT Sε = +2.8501272E-02
N = 66 DEGREES OF FREEDOM - 64
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRAIN AT RUPTURE
UNIT OF MEASURE = IN/IN
0.08
0.16
0.24
0.32
0.40
0.48
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
DISSECTED TP-H1011,H.R.TRIAXIAL CHS=1750 IN/MIN,600 PSI,STRAIN AT RUPTURE

Figure 18

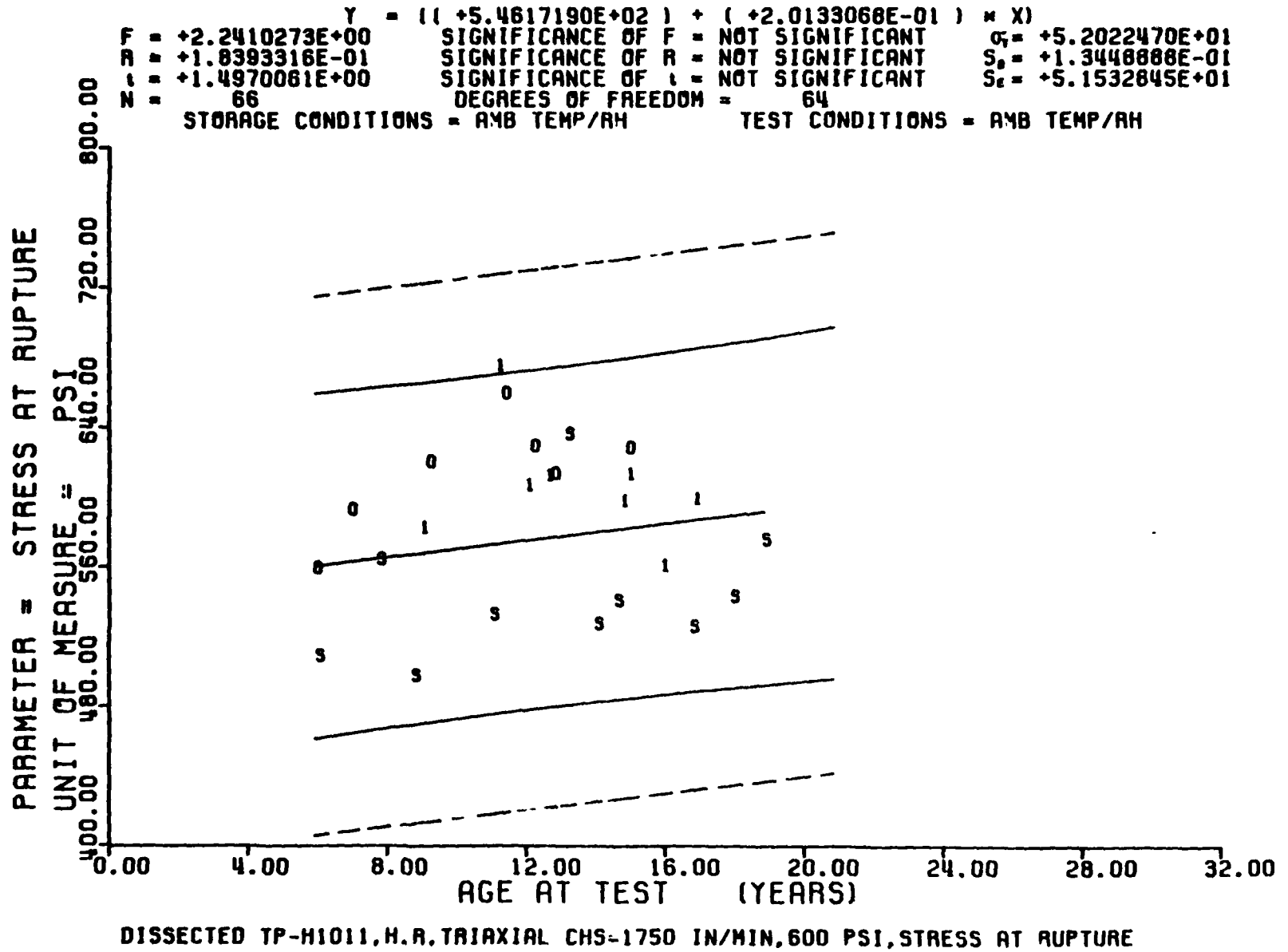
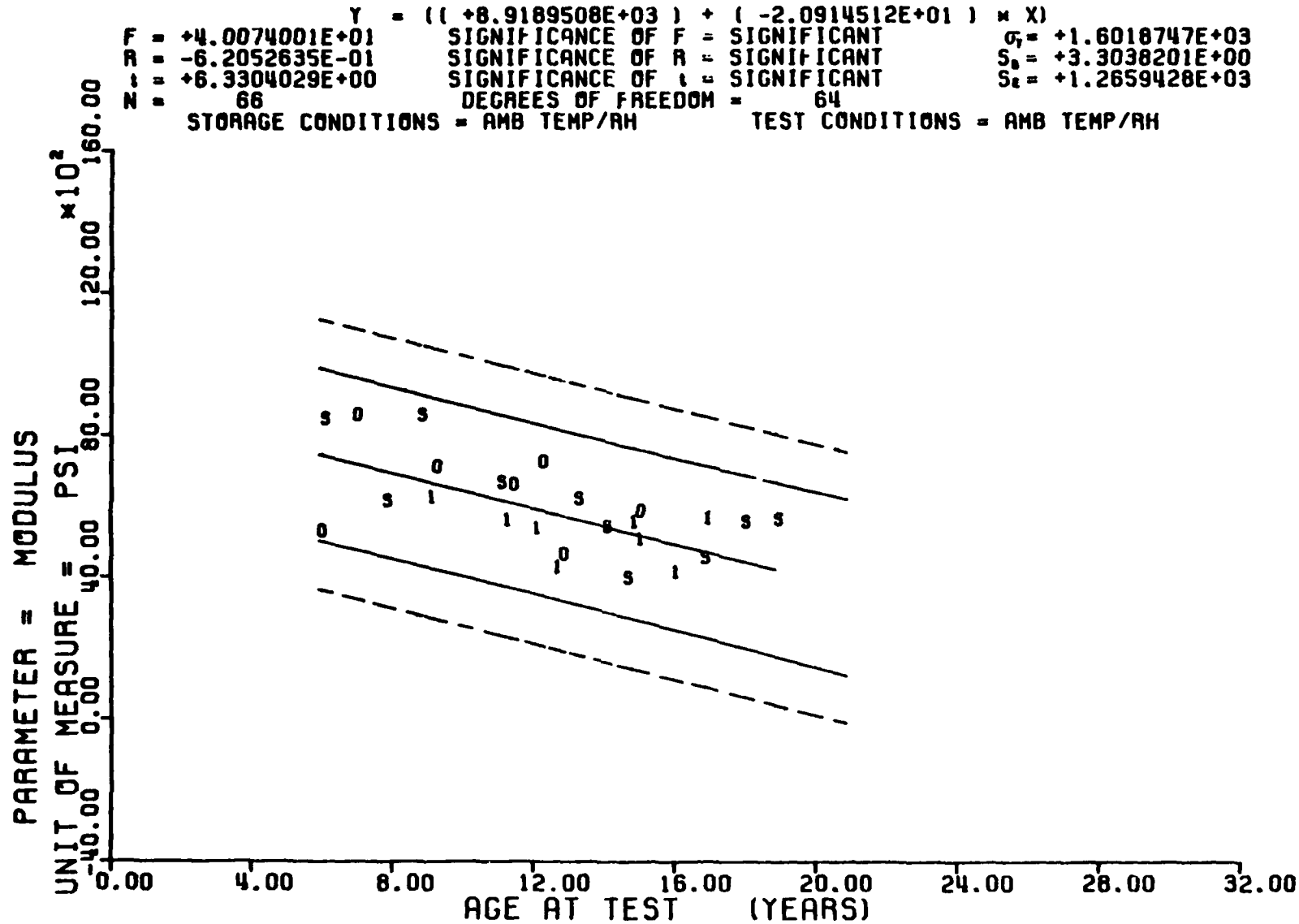

Y = ((+5.4617190E+02) + (+2.0133068E-01) * X)
F = +2.2410273E+00 SIGNIFICANCE OF F = NOT SIGNIFICANT σ1 = +5.2022470E+01
R = +1.8393316E-01 SIGNIFICANCE OF R = NOT SIGNIFICANT Se = +1.3448888E-01
t = +1.4970061E+00 SIGNIFICANCE OF t = NOT SIGNIFICANT Sε = +5.1532845E+01
N = 66 DEGREES OF FREEDOM = 64
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRESS AT RUPTURE
UNIT OF MEASURE = PSI
400.00
480.00
560.00
640.00
720.00
800.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
DISSECTED TP-H1011,H.R.TRIAXIAL CHS-1750 IN/MIN,600 PSI,STRESS AT RUPTURE

Figure 19



DISSECTED TP-H1011,H.R.TRIAXIAL CHS=1750 IN/MIN,600 PSI,MODULUS

Figure 20

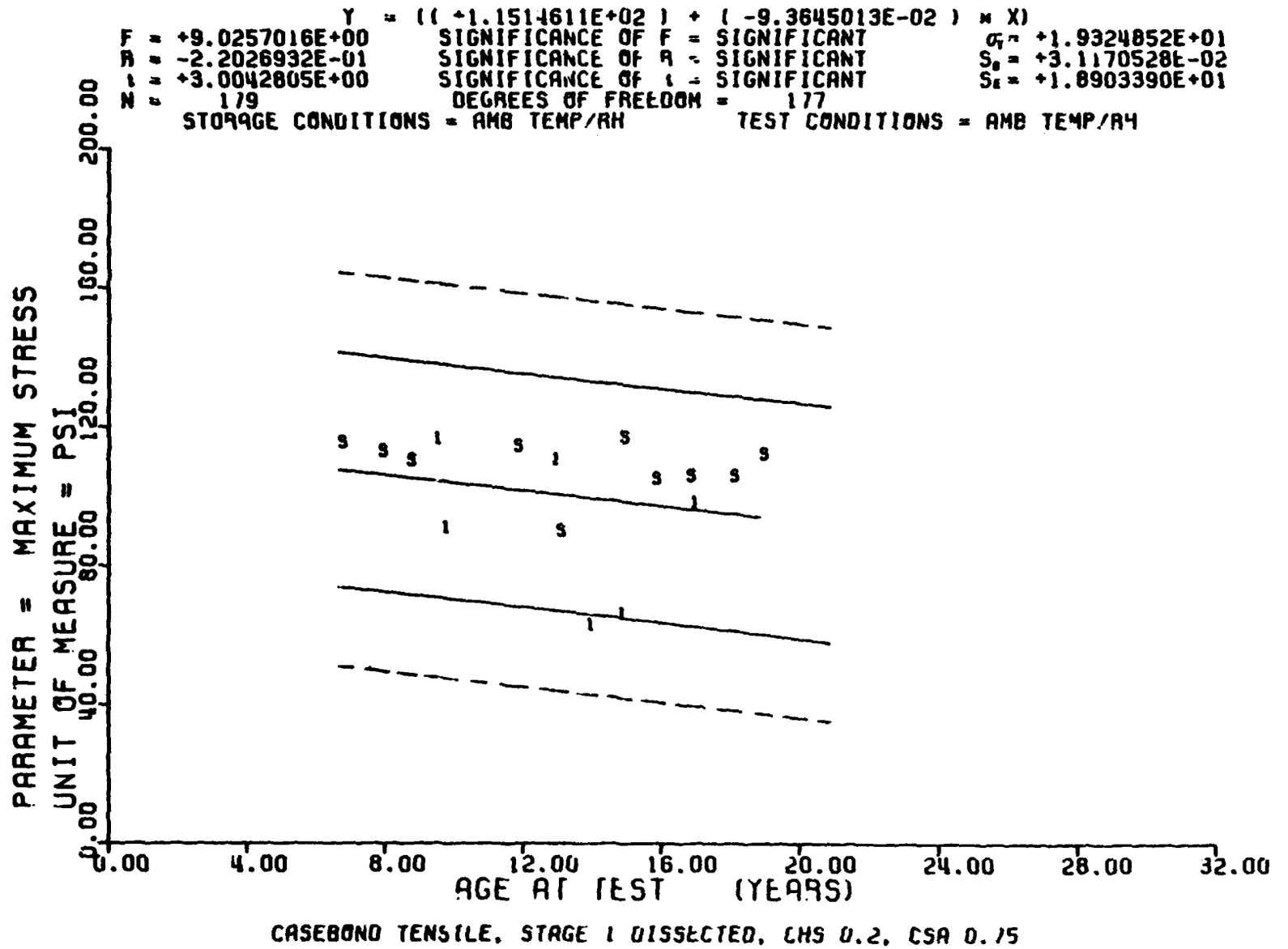

Y = ((+1.1514611E+02) + (-9.3645013E-02) * X)
F = +9.0257016E+00 SIGNIFICANCE OF F = SIGNIFICANT σT = +1.9324852E+01
R = -2.2026932E-01 SIGNIFICANCE OF R = SIGNIFICANT Se = +3.1170528E-02
t = +3.0042805E+00 SIGNIFICANCE OF t = SIGNIFICANT Sx = +1.8903390E+01
N = 179 DEGREES OF FREEDOM = 177
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = MAXIMUM STRESS
UNIT OF MEASURE = PSI
0.00
40.00
80.00
120.00
160.00
200.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
CASEBOND TENSILE, STAGE 1 DISSECTED, CHS 0.2, CSA 0.75

Figure 21

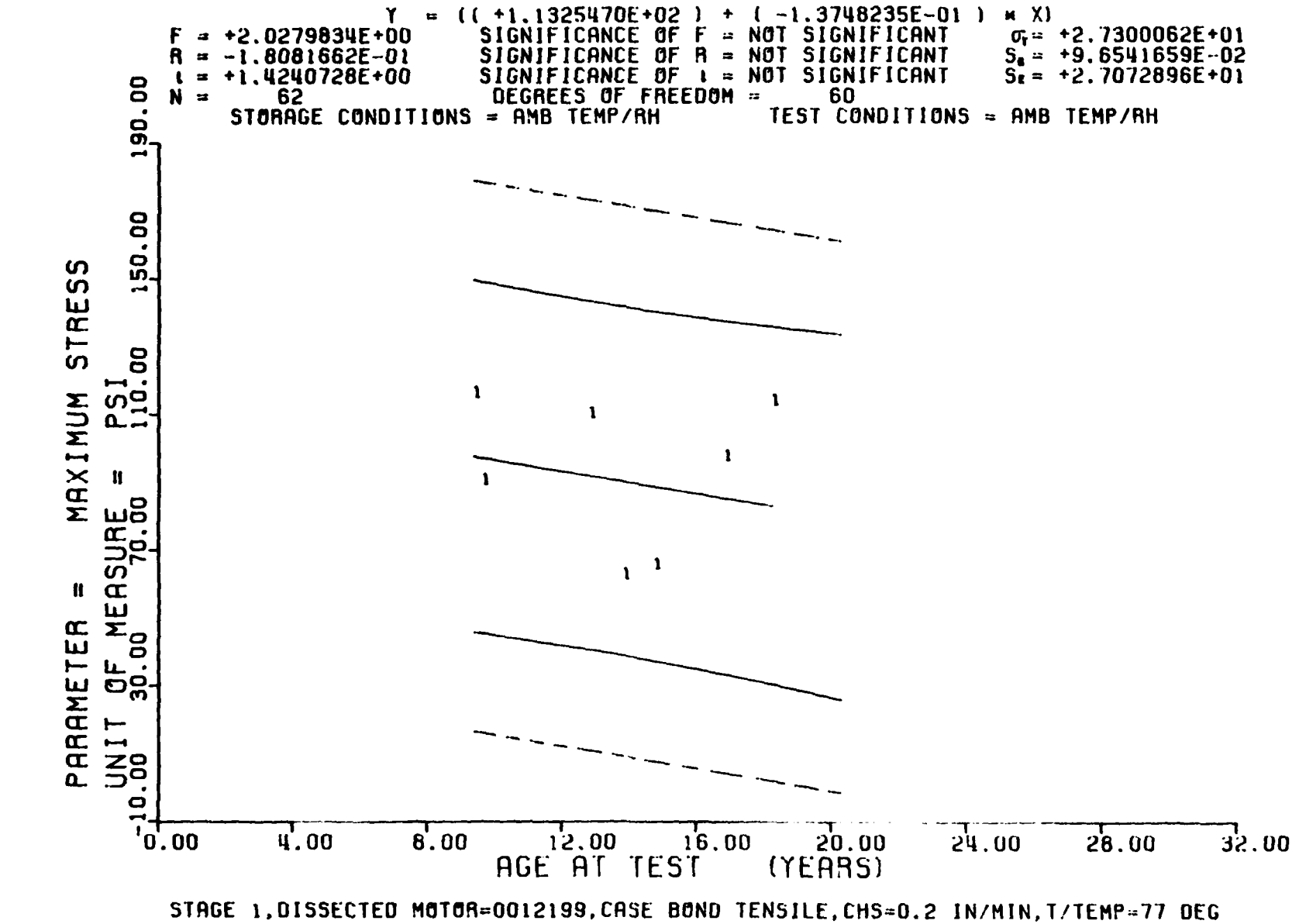

Y = ((+1.1325470E+02) + (-1.3748235E-01) * X)
F = +2.0279834E+00 SIGNIFICANCE OF F = NOT SIGNIFICANT σr = +2.7300062E+01
R = -1.8081662E-01 SIGNIFICANCE OF R = NOT SIGNIFICANT Sa = +9.6541659E-02
t = +1.4240728E+00 SIGNIFICANCE OF t = NOT SIGNIFICANT St = +2.7072896E+01
N = 62 DEGREES OF FREEDOM = 60
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = MAXIMUM STRESS
UNIT OF MEASURE = PSI
190.00
150.00
110.00
70.00
30.00
-10.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1,DISSECTED MOTOR=0012199,CASE BOND TENSILE,CHS=0.2 IN/MIN,T/TEMP=77 DEG

Figure 21-A

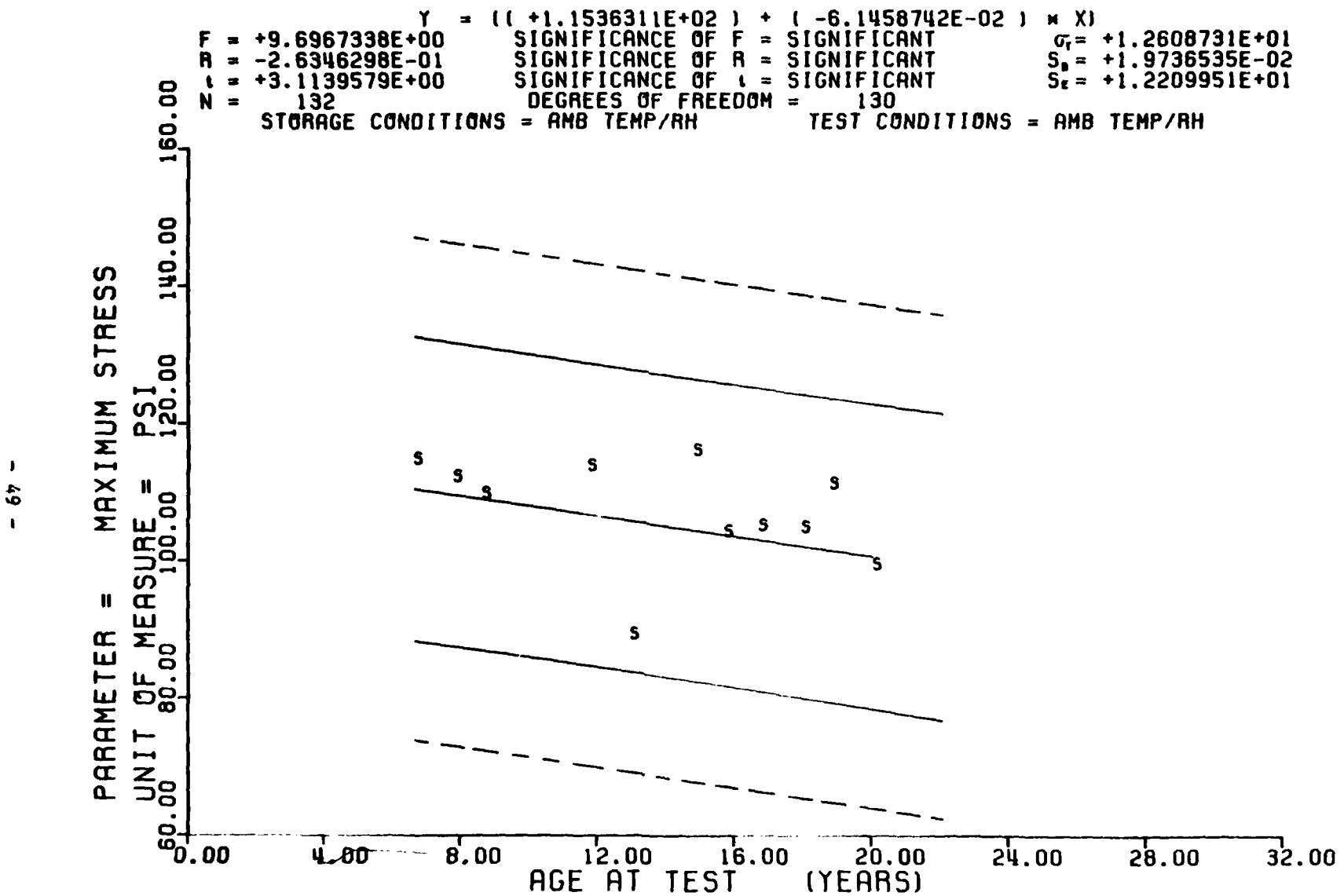
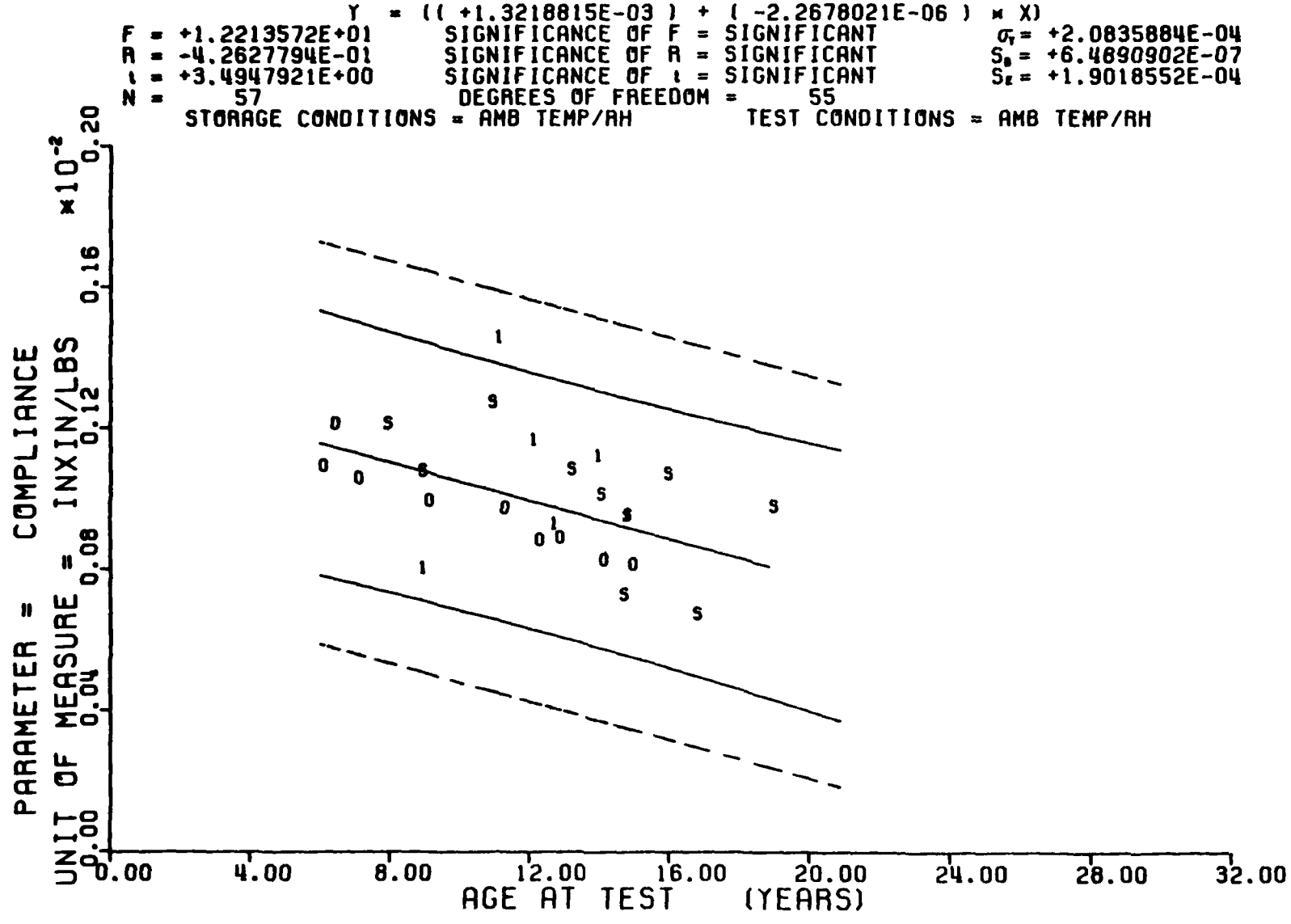
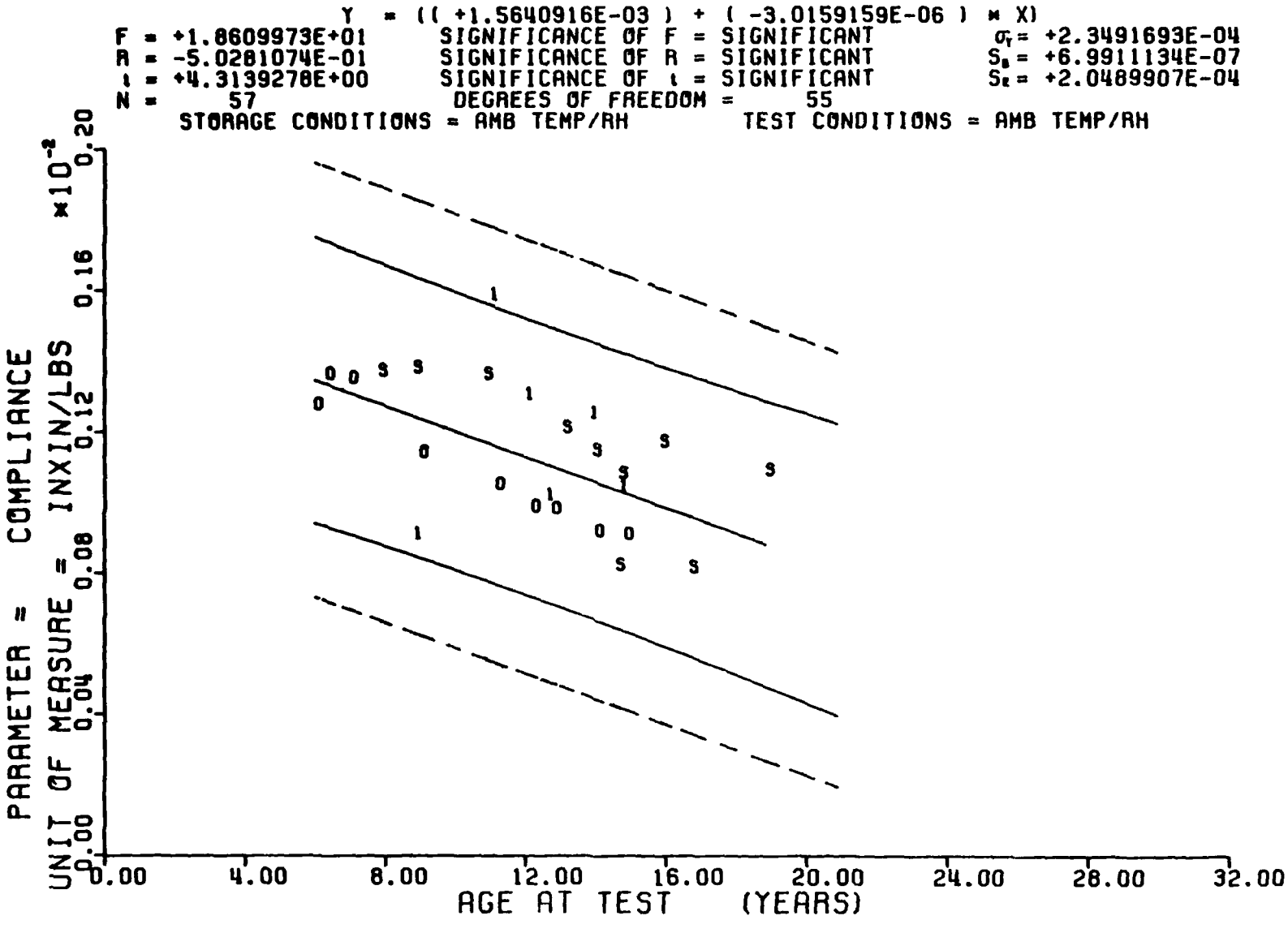

Y = ((+1.1536311E+02) + (-6.1458742E-02) * X)
F = +9.6967338E+00 SIGNIFICANCE OF F = SIGNIFICANT
R = -2.6346298E-01 SIGNIFICANCE OF R = SIGNIFICANT
t = +3.1139579E+00 SIGNIFICANCE OF t = SIGNIFICANT
N = 132 DEGREES OF FREEDOM = 130
STORAGE CONDITIONS = AMB TEMP/RH
TEST CONDITIONS = AMB TEMP/RH
σT = +1.2608731E+01
Sb = +1.9736535E-02
Sε = +1.2209951E+01
PARAMETER = MAXIMUM STRESS
UNIT OF MEASURE = PSI
160.00
140.00
120.00
100.00
80.00
60.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1,DISSECTED MOTOR=STM-012,CASE BOND TENSILE,CHS=0.2 IN/MIN,T/TEMP=77 DEG

Figure 21-B



DISSECTED MOTOR TP-H1011, CREEP 10 LB LOAD, COMPLIANCE AT 10 SEC.

Figure 22



DISSECTED MOTOR TP-H1011, CREEP 10 LB LOAD, COMPLIANCE AT 20 SEC.

Figure 23

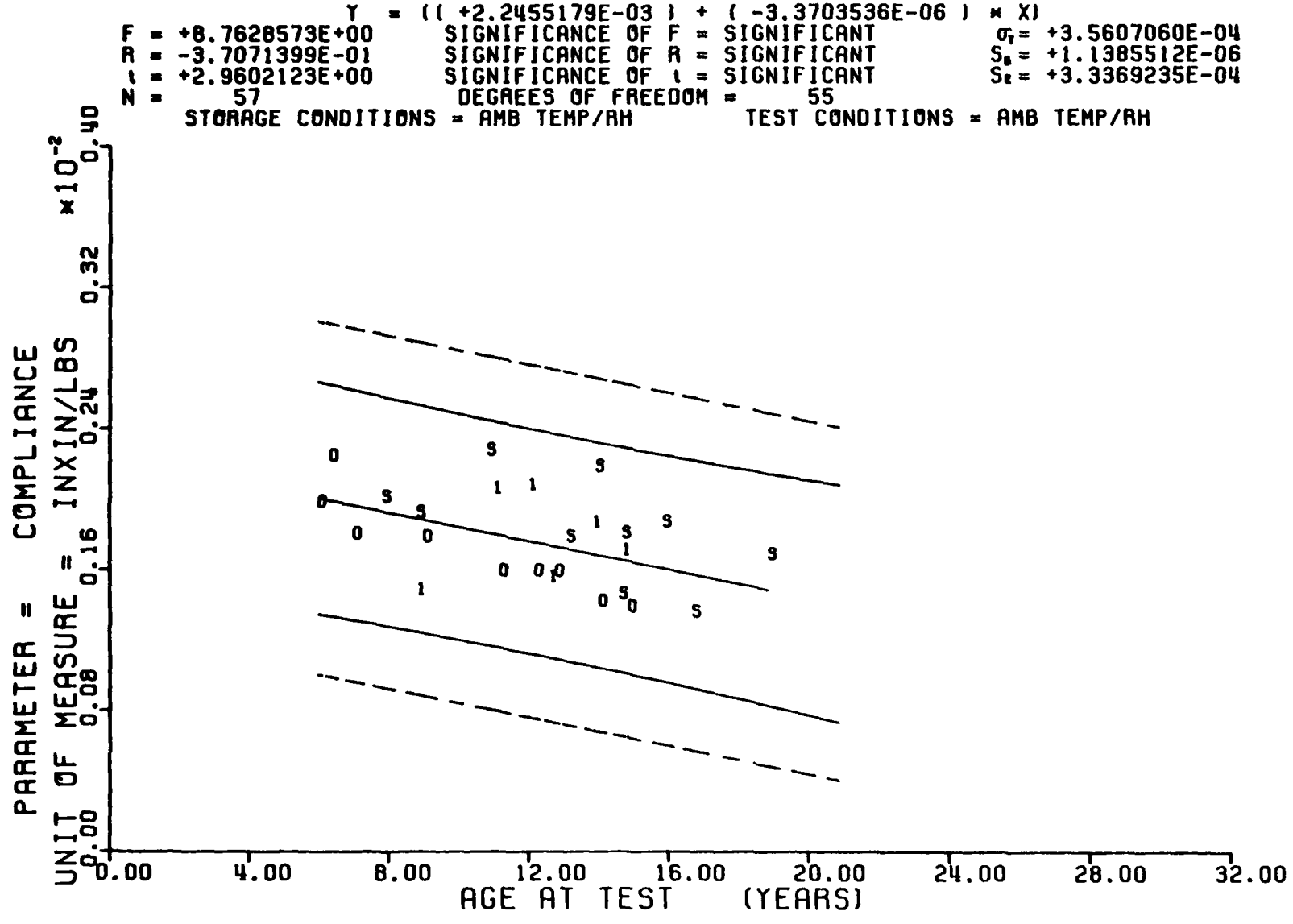
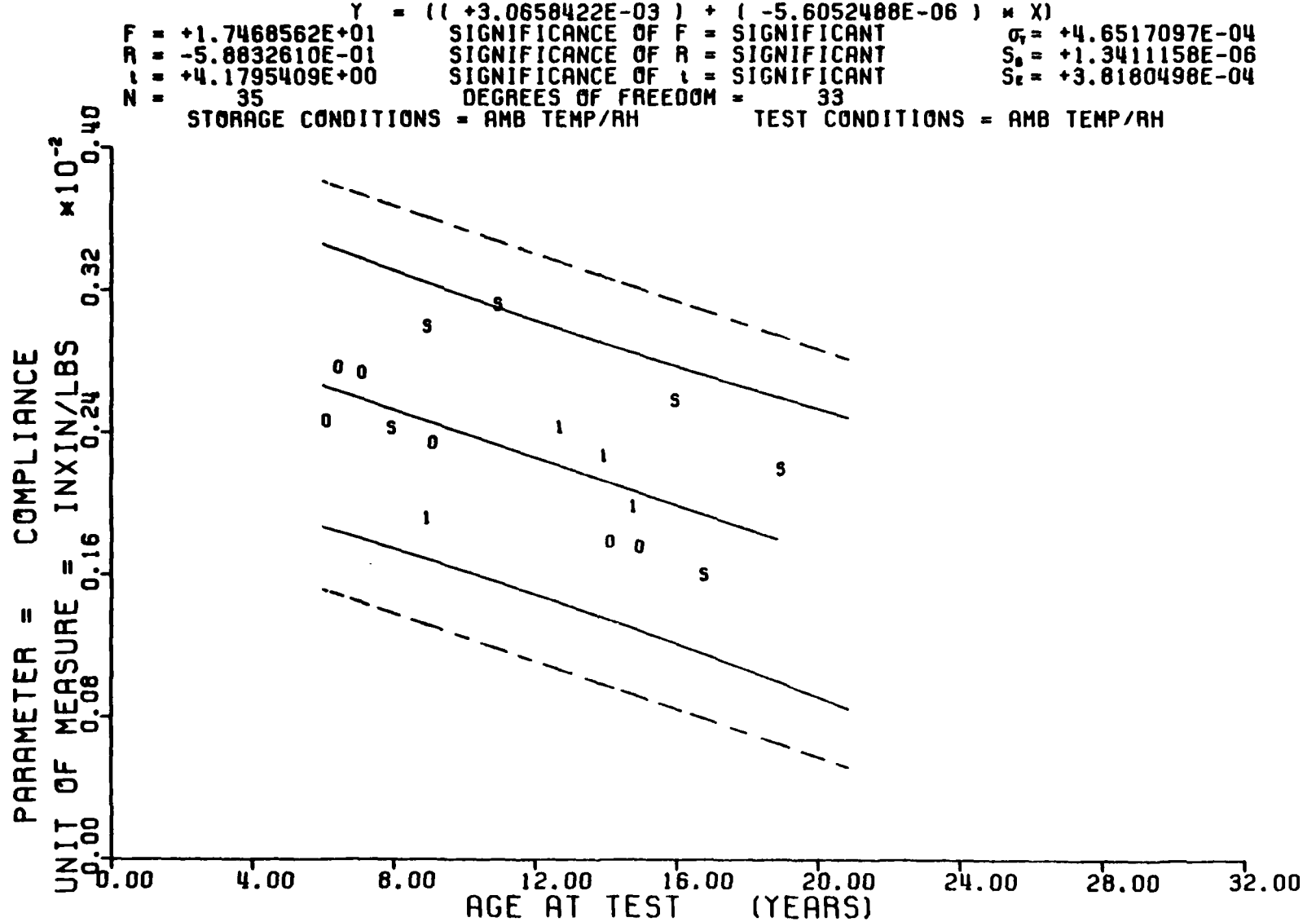
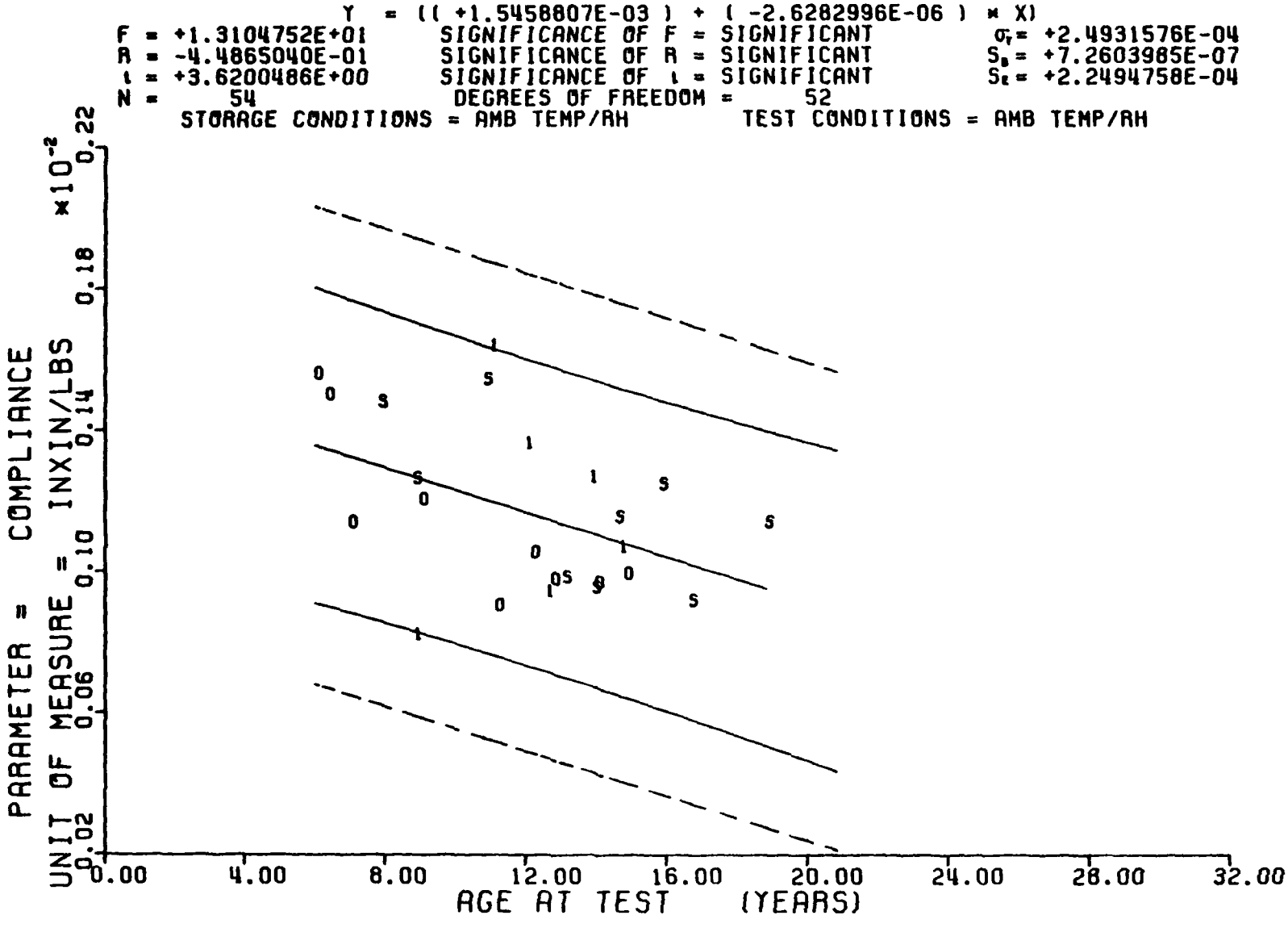

Y = ((+2.2455179E-03) + (-3.3703536E-06) × X)
F = +8.7628573E+00 SIGNIFICANCE OF F = SIGNIFICANT σT = +3.5607060E-04
R = -3.7071399E-01 SIGNIFICANCE OF R = SIGNIFICANT Sb = +1.1385512E-06
t = +2.9602123E+00 SIGNIFICANCE OF t = SIGNIFICANT Se = +3.3369235E-04
N = 57 DEGREES OF FREEDOM = 55
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = COMPLIANCE
UNIT OF MEASURE = INXIN/LBS ×10⁻²
0.00
0.08
0.16
0.24
0.32
0.40
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
DISSECTED MOTOR TP-H1011,CREEP 10 LB LOAD,COMPLIANCE AT 1000 SEC.

Figure 24



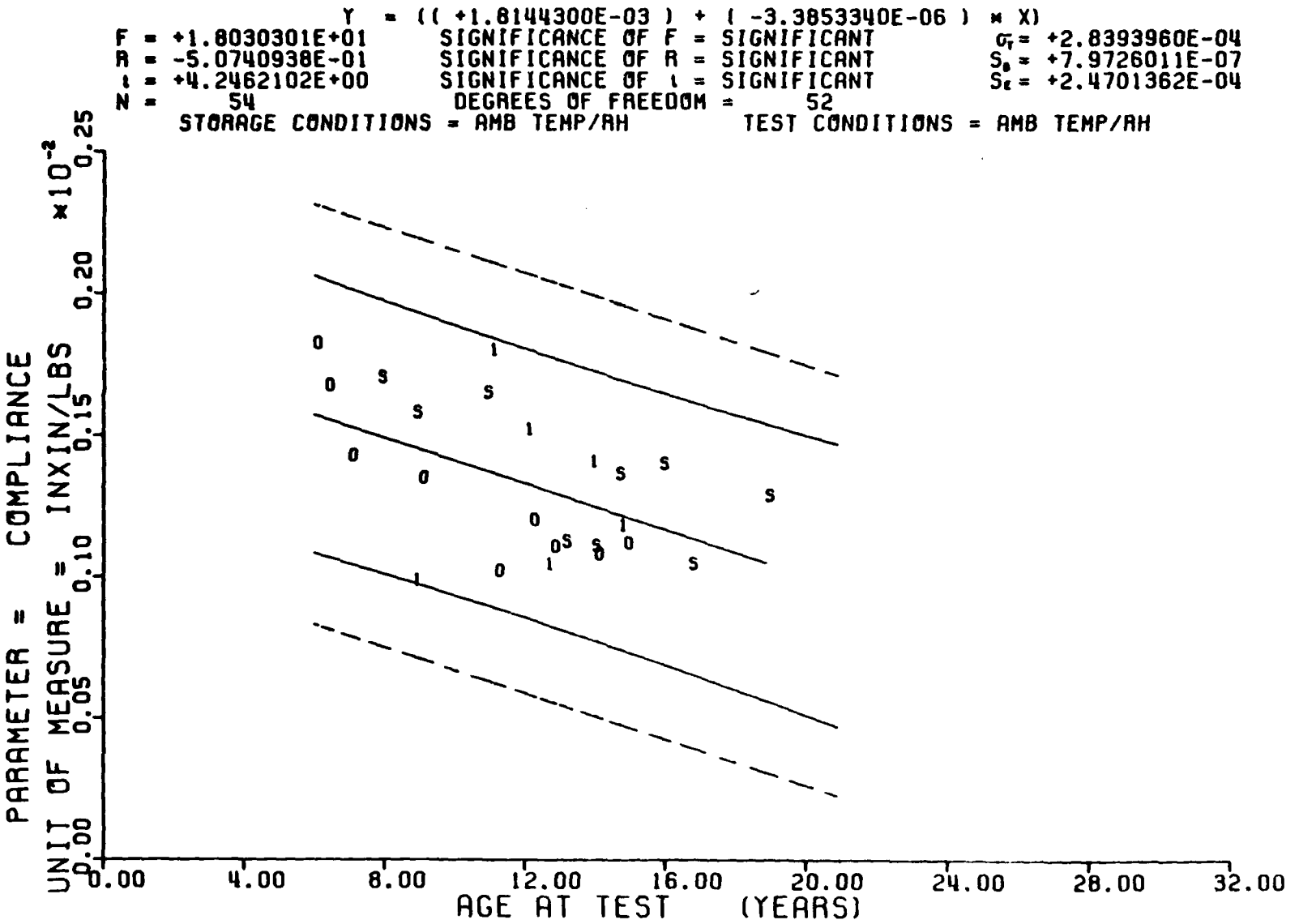
DISSECTED MOTOR TP-H1011, CREEP 10 LB LOAD, COMPLIANCE AT 10,000 SEC.

Figure 25



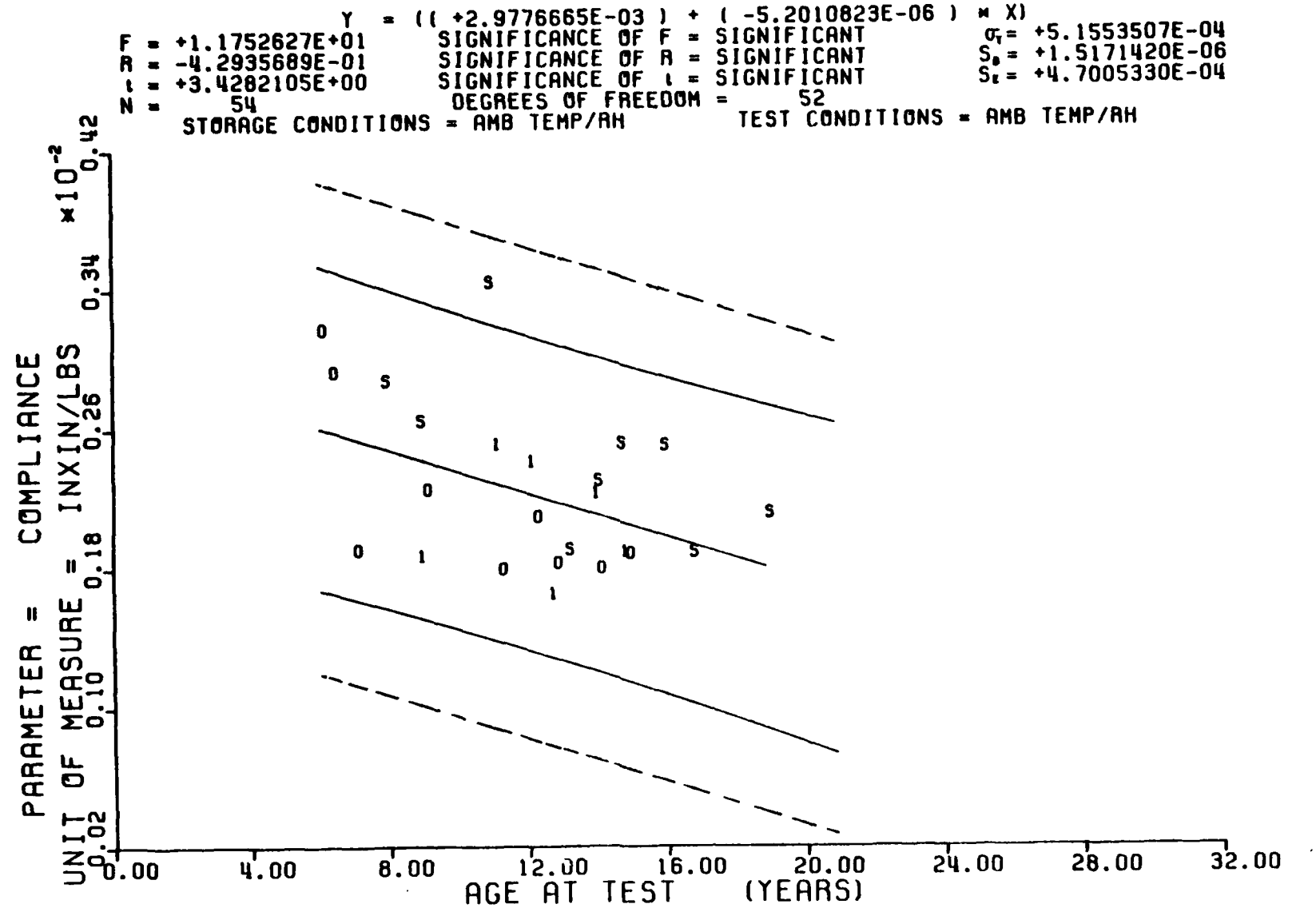
DISSECTED MOTOR TP-H1011, CREEP 12 LB LOAD, COMPLIANCE AT 10 SEC.

Figure 26



DISSECTED MOTOR TP-H1011, CREEP 12 LB LOAD, COMPLIANCE AT 20 SEC.

Figure 27



DISSECTED MOTOR TP-H1011,CREEP 12 LB LOAD,COMPLIANCE AT 1000 SEC.

Figure 28

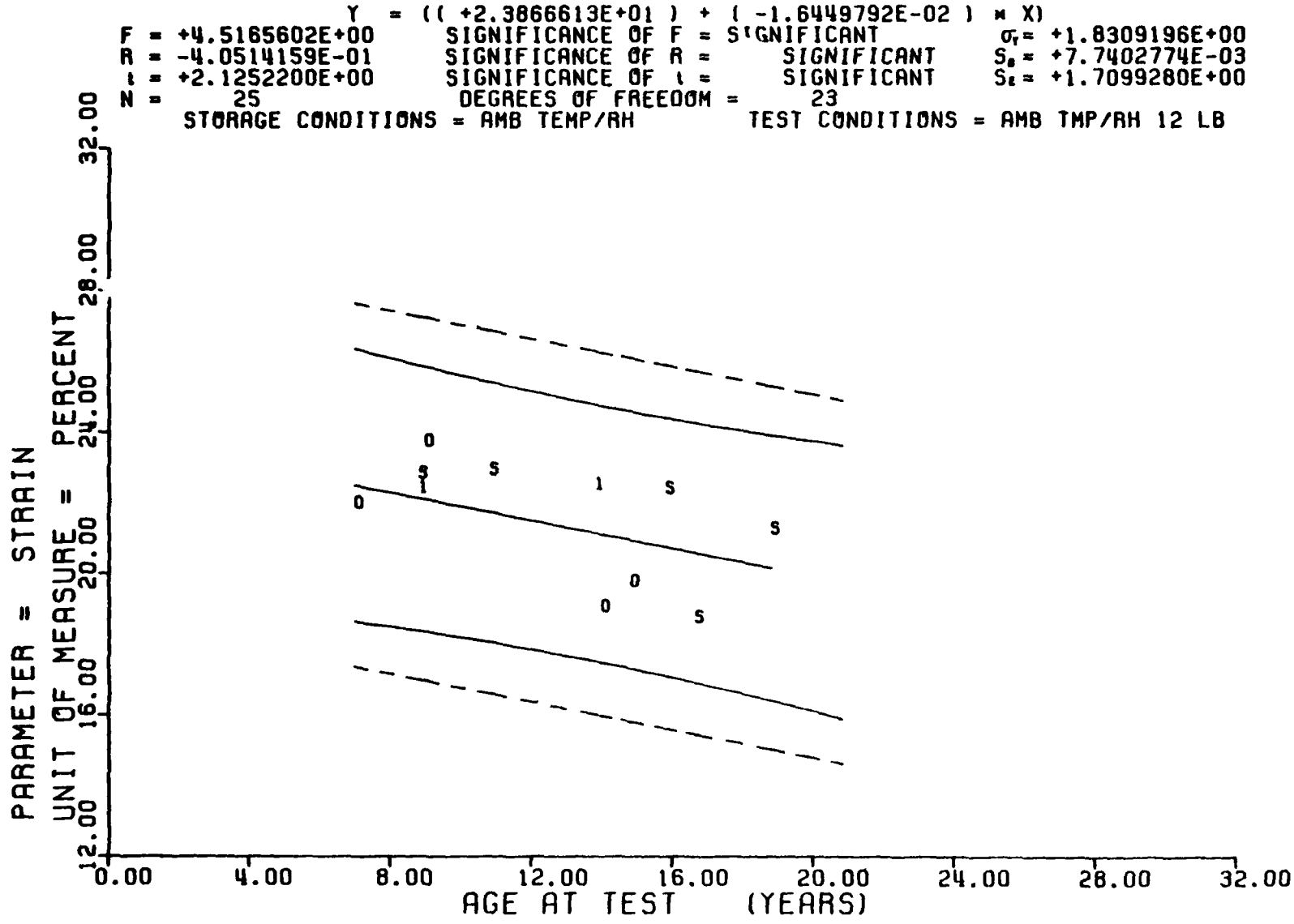
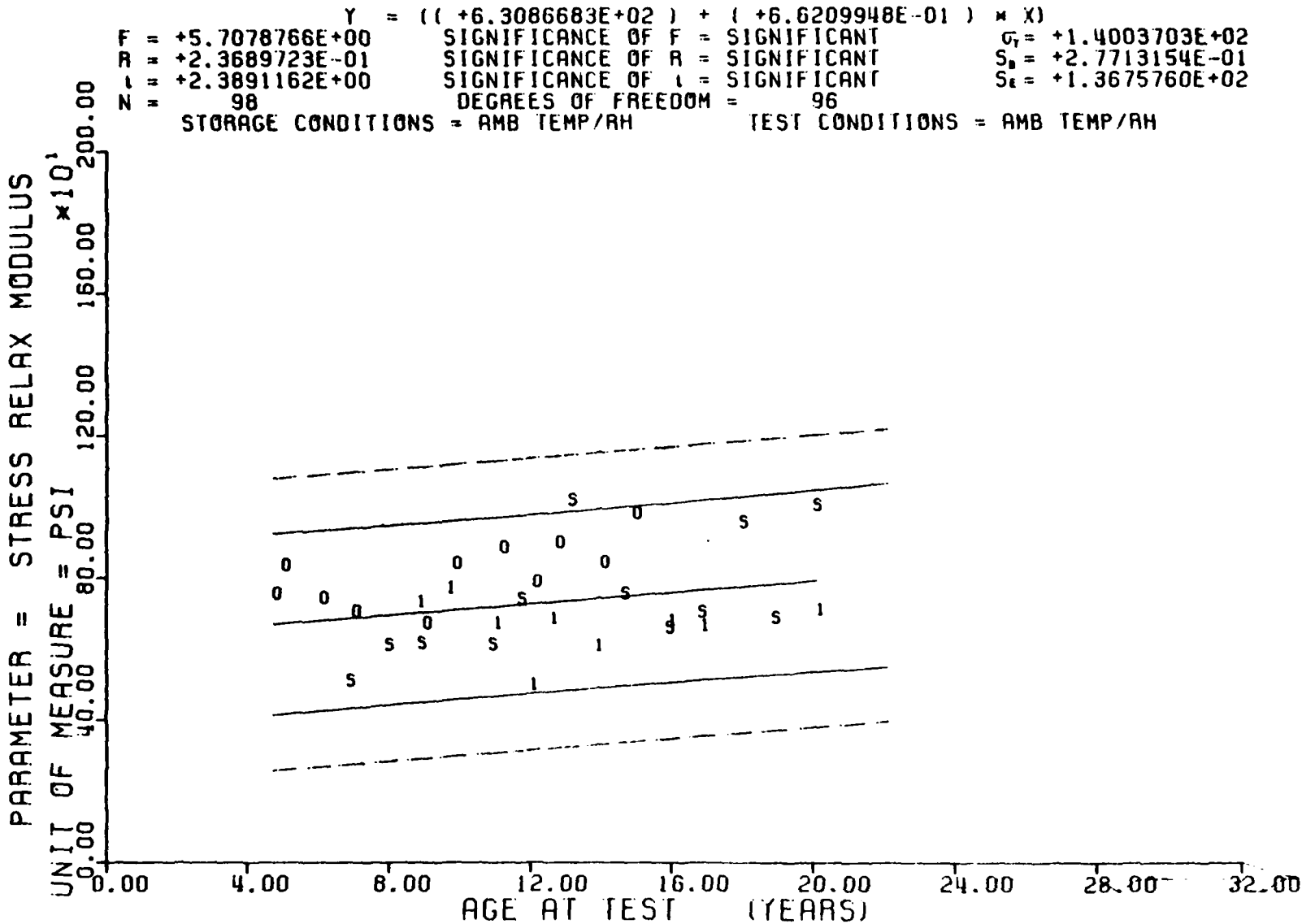
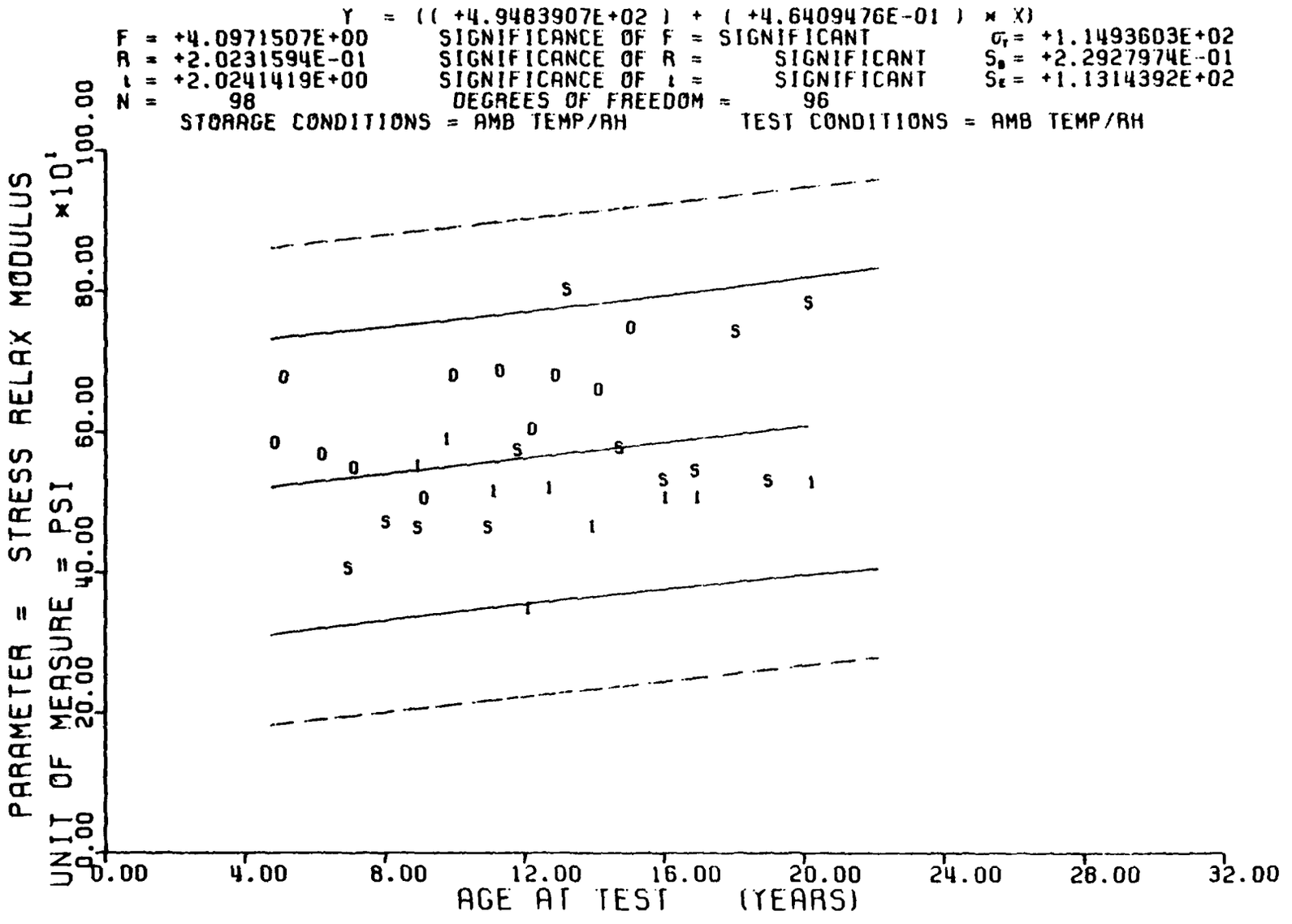

Y = ((+2.3866613E+01) + (-1.6449792E-02) * X)
F = +4.5165602E+00 SIGNIFICANCE OF F = SIGNIFICANT σt = +1.8309196E+00
R = -4.0514159E-01 SIGNIFICANCE OF R = SIGNIFICANT Se = +7.7402774E-03
t = +2.1252200E+00 SIGNIFICANCE OF t = SIGNIFICANT St = +1.7099280E+00
N = 25 DEGREES OF FREEDOM = 23
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TMP/RH 12 LB
PARAMETER = STRAIN
UNIT OF MEASURE = PERCENT
12.00
16.00
20.00
24.00
28.00
32.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
TP-H1011 DISSECTED MOTORS, CREEP, % STRAIN AT RUPTURE, 12 LB LOAD

Figure 29



TP-H1011 DISSECTED MTAS, STRESS RELAXATION MODULUS, 3 PERCENT STRAIN, 10 SEC

Figure 30



TP-H1011 DISSECTED MTRS, STRESS RELAXATION MODULUS, 3 PERCENT STRAIN, 50 SEC

Figure 31

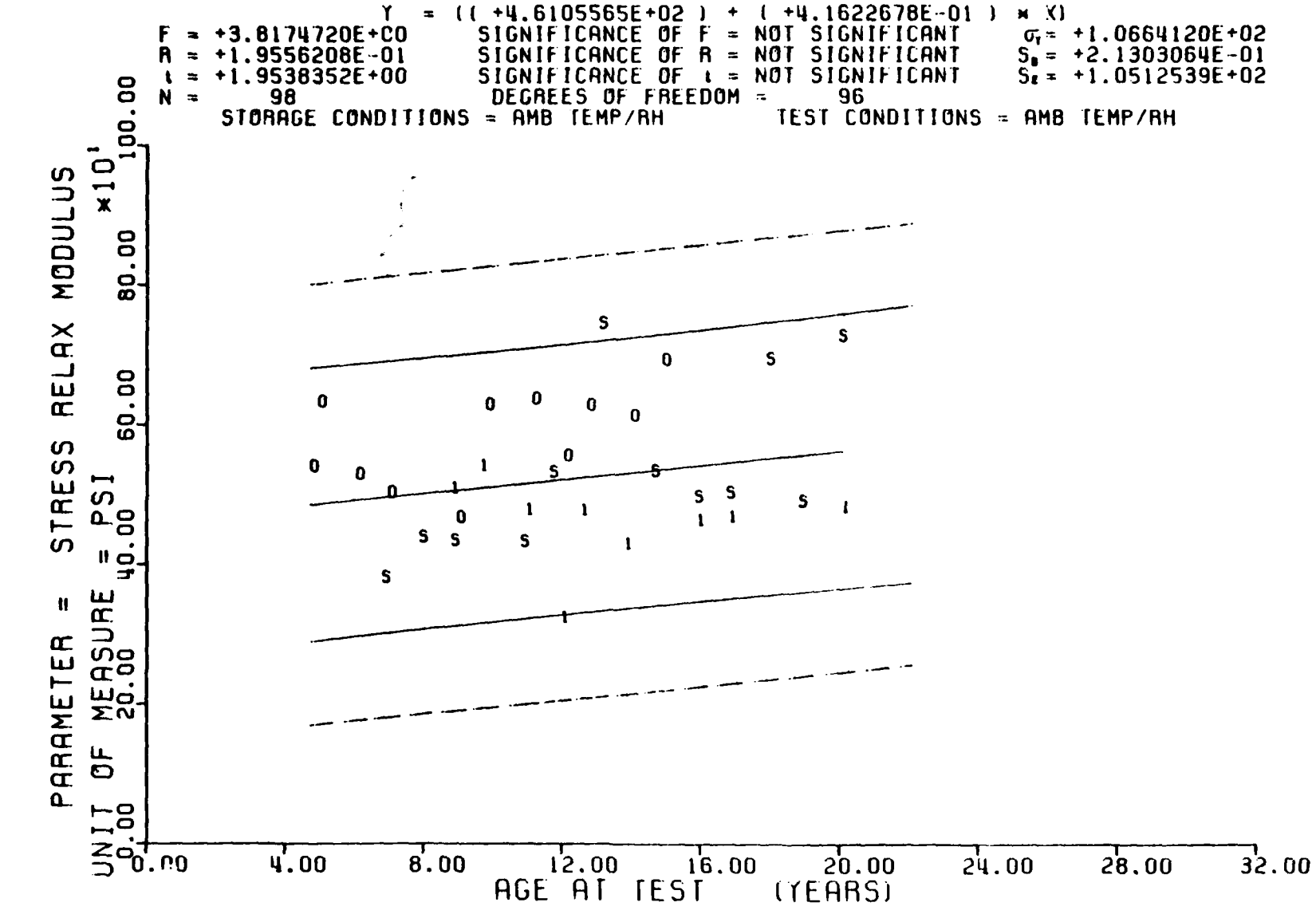
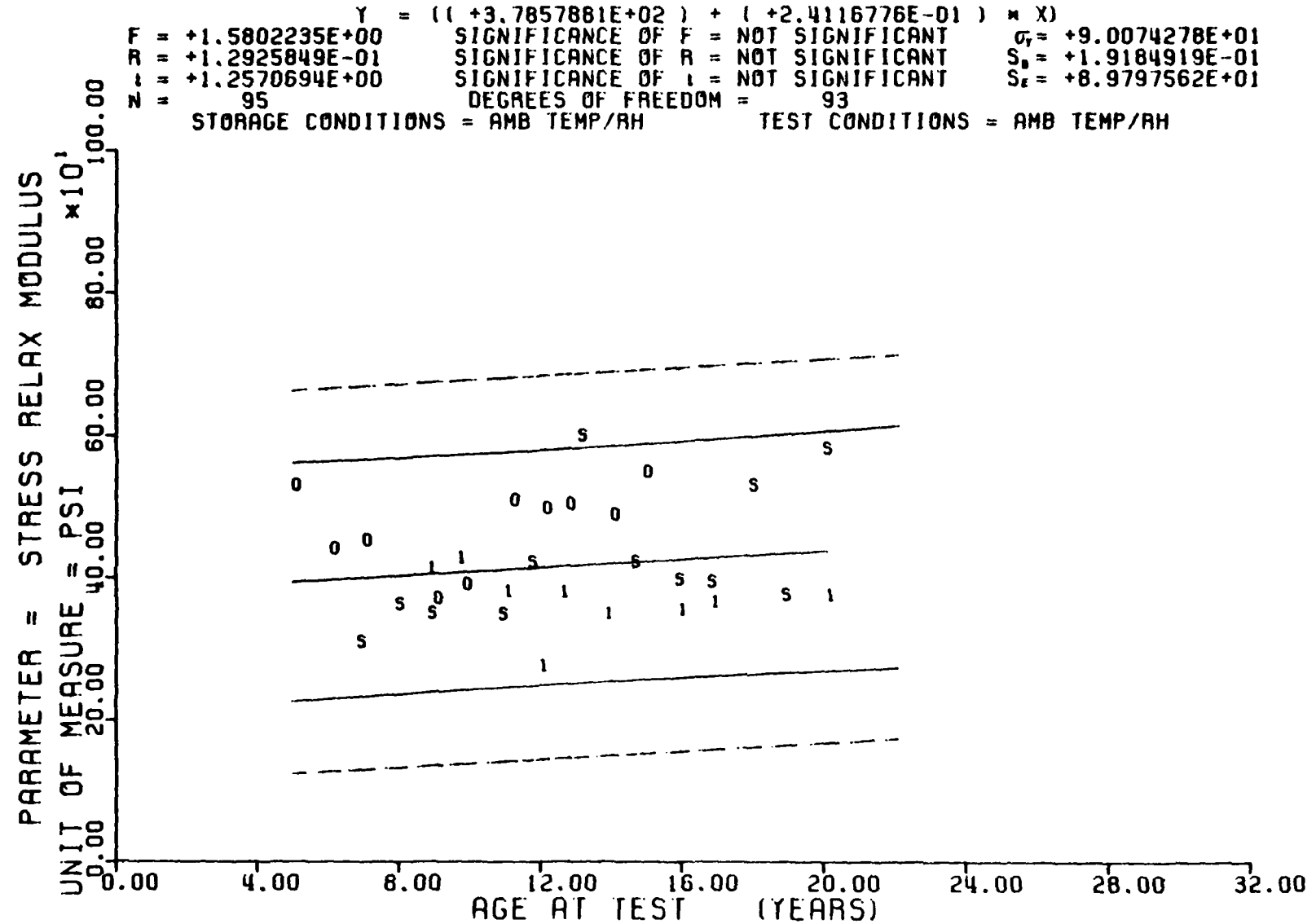
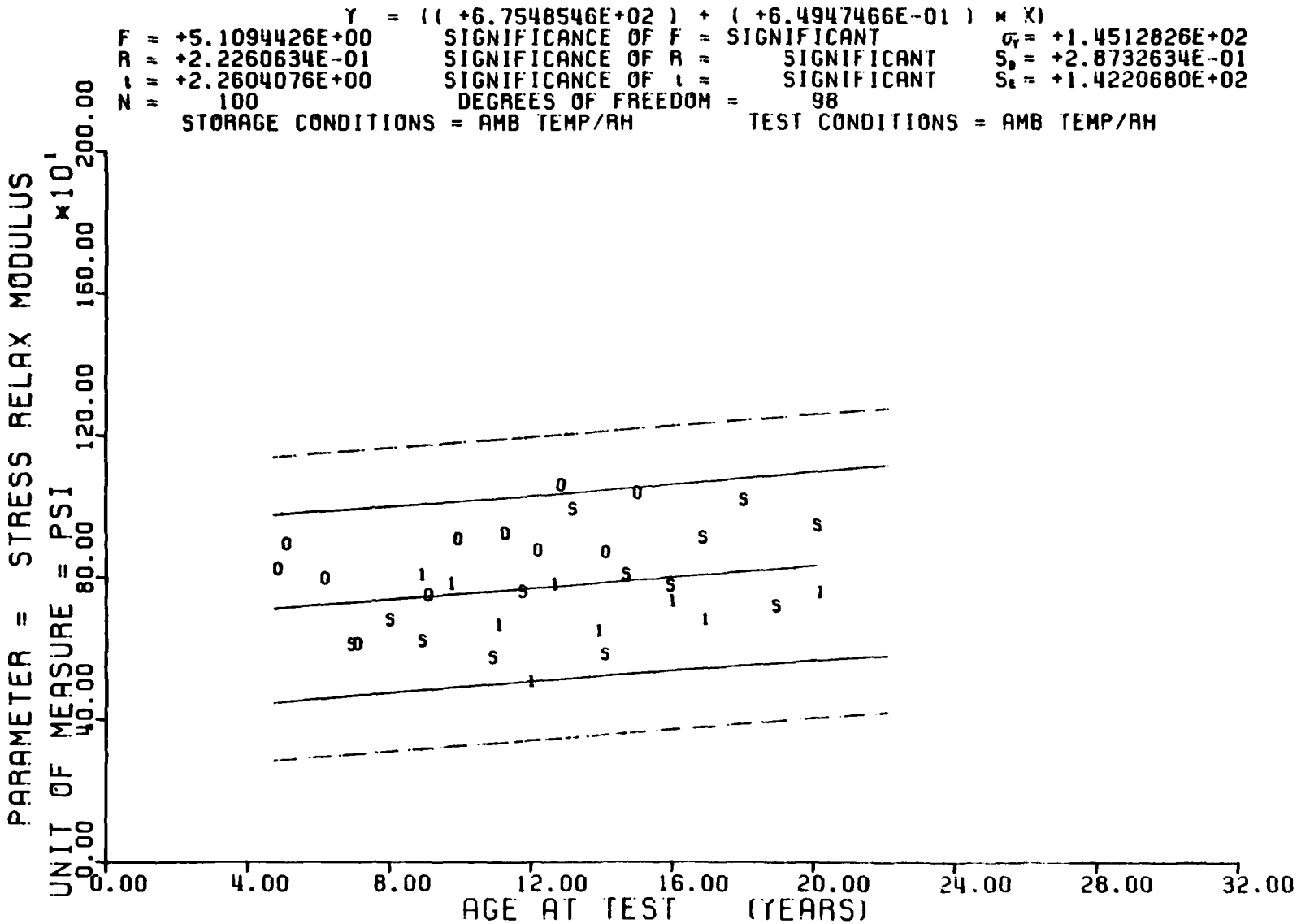

Y = ((+4.6105565E+02) + (+4.1622678E-01) * X)
F = +3.8174720E+00 SIGNIFICANCE OF F = NOT SIGNIFICANT σ_Y = +1.0664120E+02
R = +1.9556208E-01 SIGNIFICANCE OF R = NOT SIGNIFICANT S_B = +2.1303064E-01
t = +1.9538352E+00 SIGNIFICANCE OF t = NOT SIGNIFICANT S_E = +1.0512539E+02
N = 98 DEGREES OF FREEDOM = 96
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRESS RELAX MODULUS
UNIT OF MEASURE = PSI *10¹
100.00
80.00
60.00
40.00
20.00
0.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
TP-H1011 DISSECTED MTAS, STRESS RELAXATION MODULUS, 3 PERCENT STRAIN, 100 SEC

Figure 32



TP-H1011 DISSECTED MTRS, STRESS RELAXATION MODULUS, 3 PERCENT STRAIN, 1000 SEC

Figure 33



TP-H1011 DISSECTED MTRS, STRESS RELAXATION MODULUS, 5 PERCENT STRAIN, 10 SEC

Figure 34

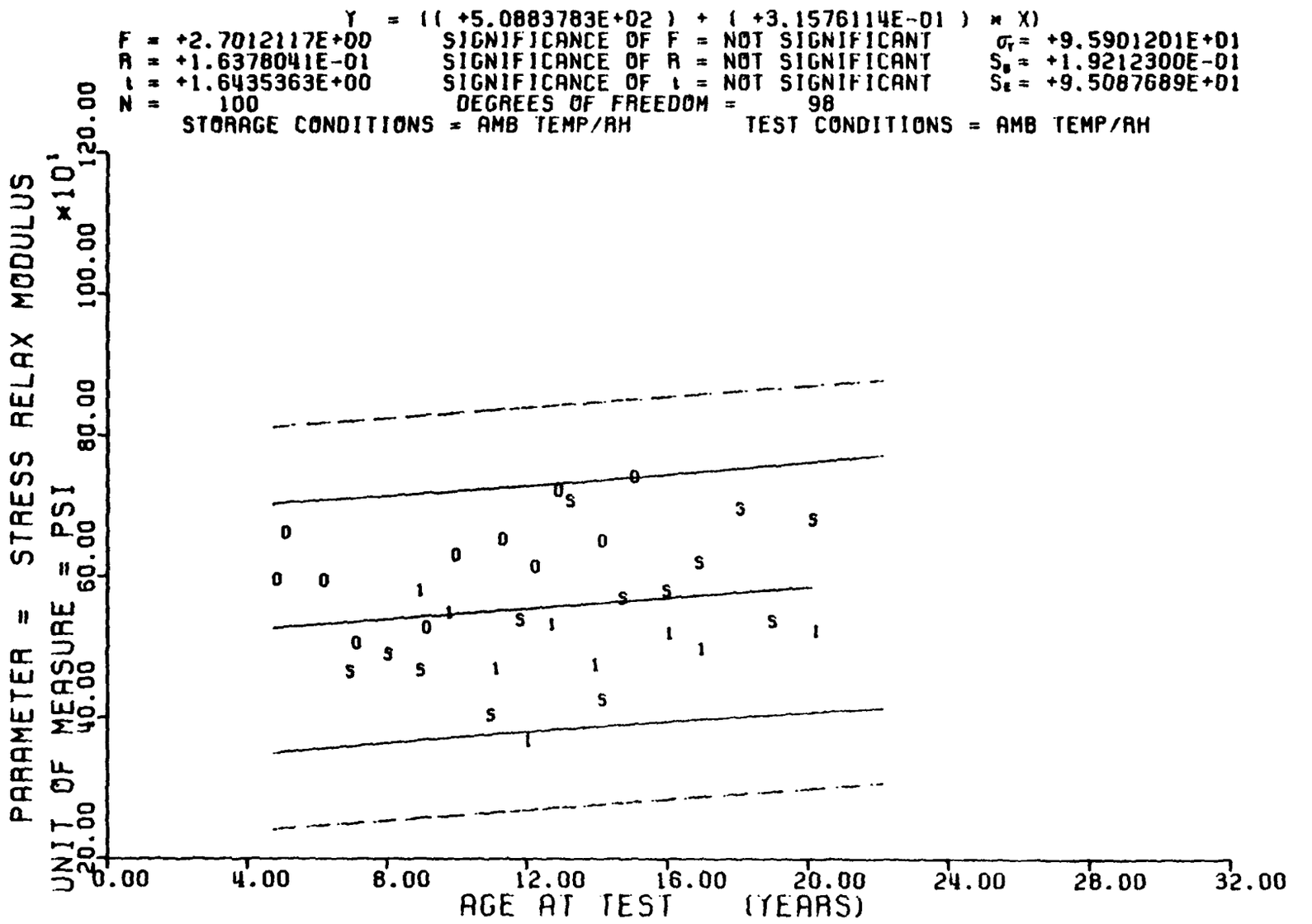

Y = ((+5.0883783E+02) + (+3.1576114E-01) * X)
F = +2.7012117E+00 SIGNIFICANCE OF F = NOT SIGNIFICANT σr = +9.5901201E+01
R = +1.6378041E-01 SIGNIFICANCE OF R = NOT SIGNIFICANT Sb = +1.9212300E-01
t = +1.6435363E+00 SIGNIFICANCE OF t = NOT SIGNIFICANT Se = +9.5087689E+01
N = 100 DEGREES OF FREEDOM = 98
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRESS RELAX MODULUS
UNIT OF MEASURE = PSI *10¹
120.00
100.00
80.00
60.00
40.00
20.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
TP-H1011 DISSECTED MTRS,STRESS RELAXATION MODULUS, 5 PERCENT STRAIN, 50 SEC

Figure 35

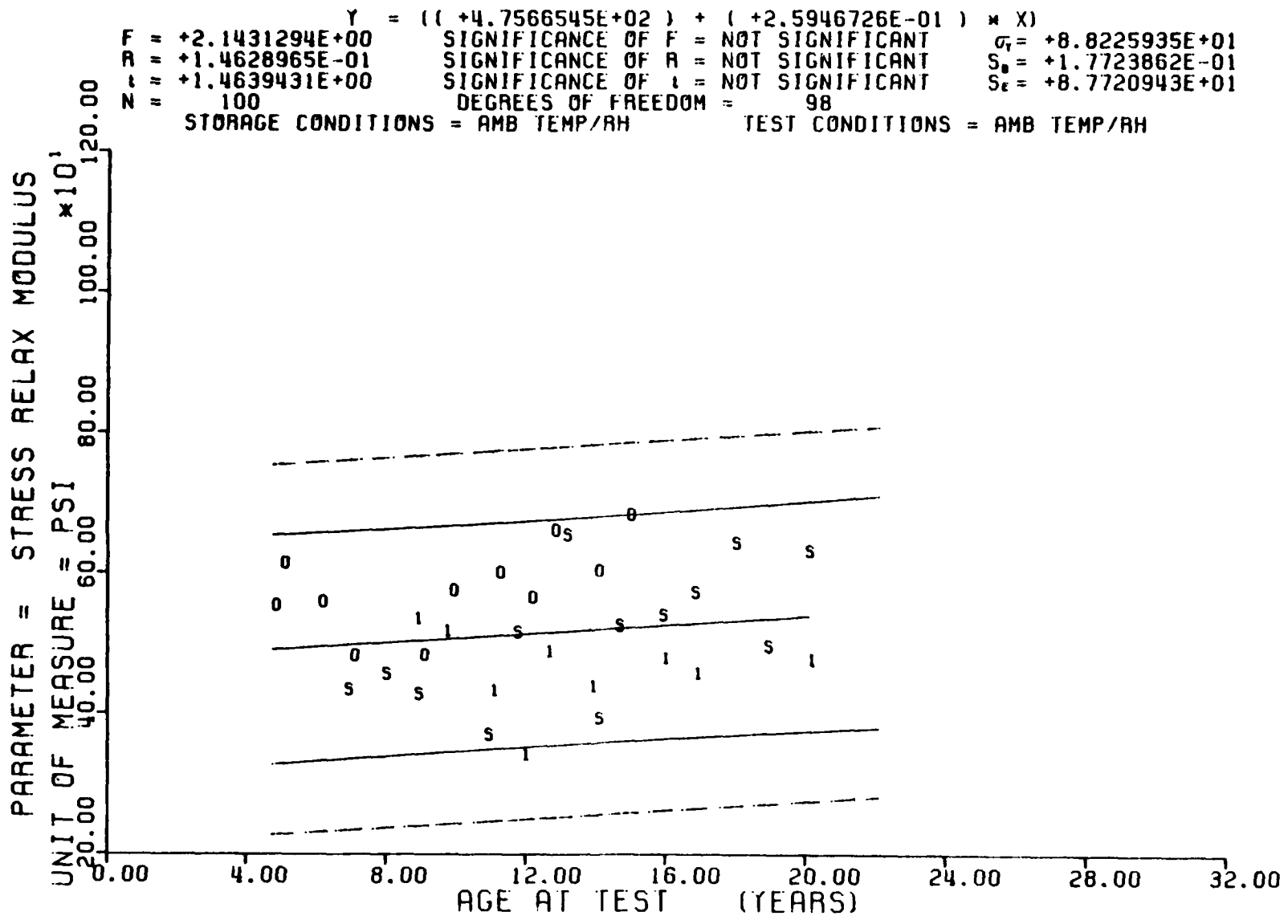
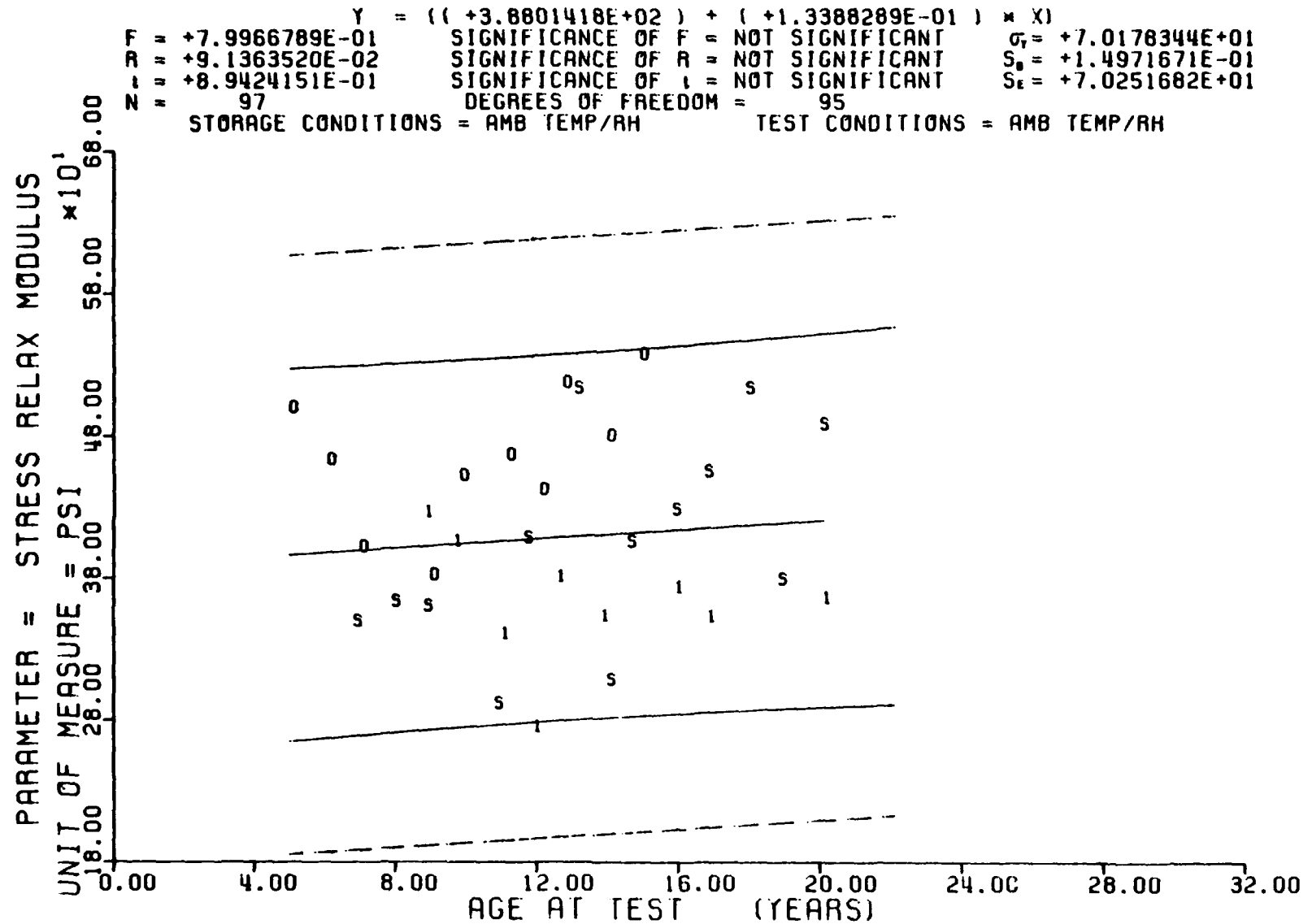

Y = ((+4.7566545E+02) + (+2.5946726E-01) * X)
F = +2.1431294E+00 SIGNIFICANCE OF F = NOT SIGNIFICANT σr = +8.8225935E+01
R = +1.4628965E-01 SIGNIFICANCE OF R = NOT SIGNIFICANT Sb = +1.7723862E-01
t = +1.4639431E+00 SIGNIFICANCE OF t = NOT SIGNIFICANT Se = +8.7720943E+01
N = 100 DEGREES OF FREEDOM = 98
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRESS RELAX MODULUS
UNIT OF MEASURE = PSI *10¹
120.00
100.00
80.00
60.00
40.00
20.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
TP-H1011 DISSECTED MTRS, STRESS RELAXATION MODULUS, 5 PERCENT STRAIN, 100 SEC

Figure 36



TP-H1011 DISSECTED MTRS, STRESS RELAXATION MODULUS, 5 PERCENT STRAIN, 1000 SEC

Figure 37

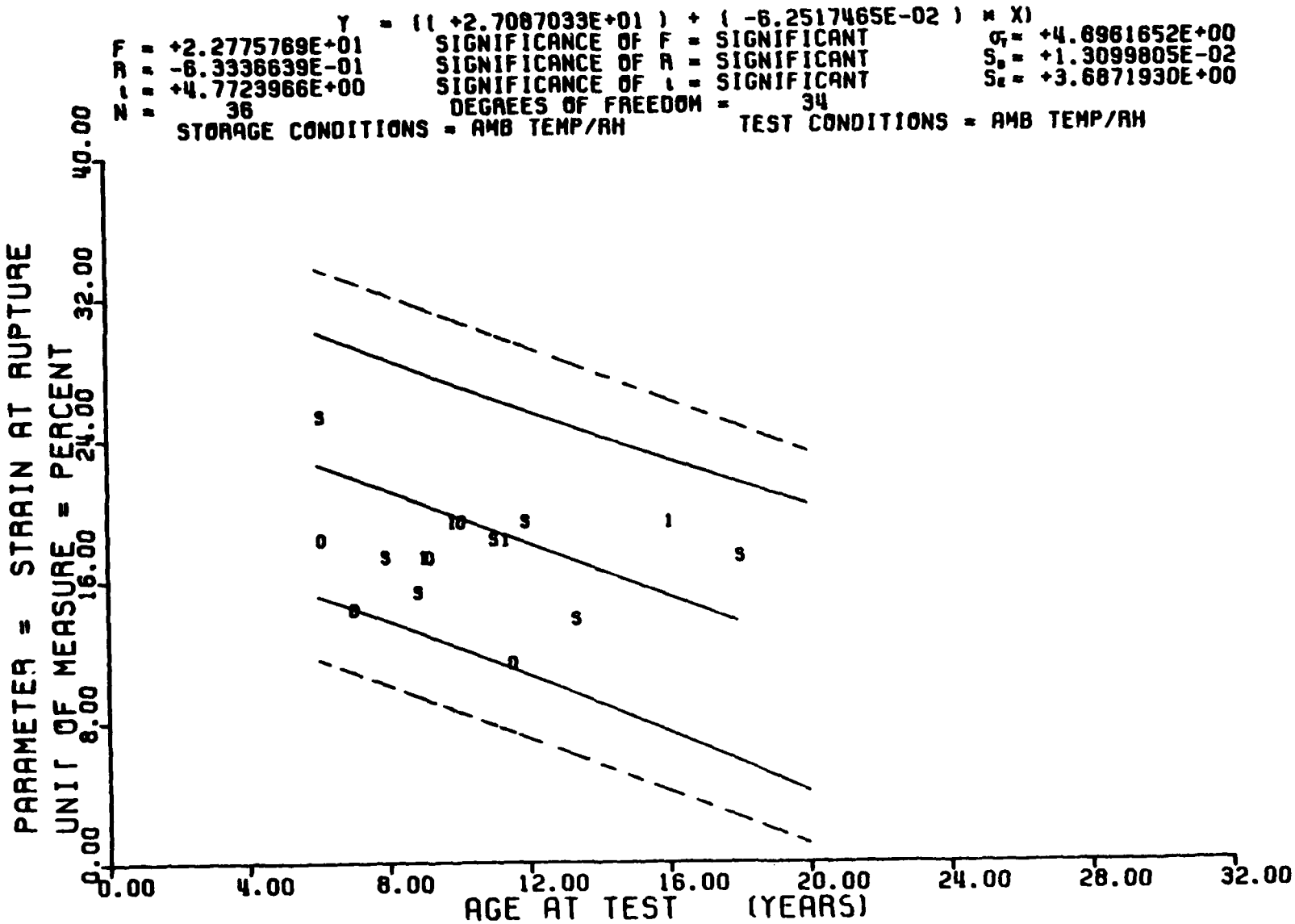

Y = (+2.7087033E+01) + (-6.2517465E-02) * X)
F = +2.2775769E+01
R = -6.3336639E-01
t = +4.7723966E+00
N = 36
SIGNIFICANCE OF F = SIGNIFICANT
SIGNIFICANCE OF R = SIGNIFICANT
SIGNIFICANCE OF t = SIGNIFICANT
DEGREES OF FREEDOM = 34
σr = +4.6961652E+00
Se = +1.3099805E-02
Sa = +3.6871930E+00
STORAGE CONDITIONS = AMB TEMP/RH
TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRAIN AT RUPTURE
UNIT OF MEASURE = PERCENT
0.00
8.00
16.00
24.00
32.00
40.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DSSCTD MTRS, CONSTANT STRAIN, STRAIN 0.1 INIT AND 0.01 EVERY 48 HRS

Figure 38

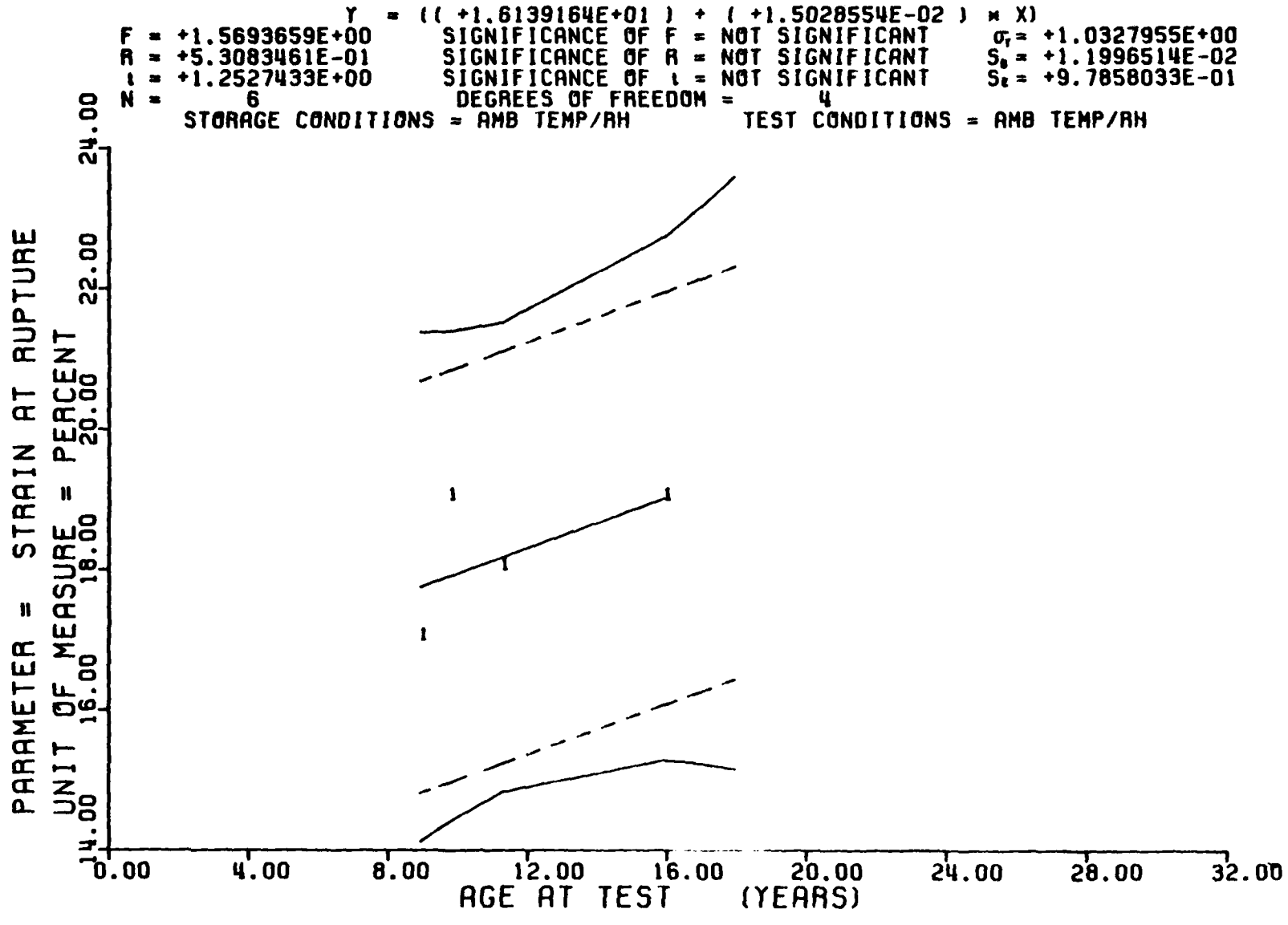
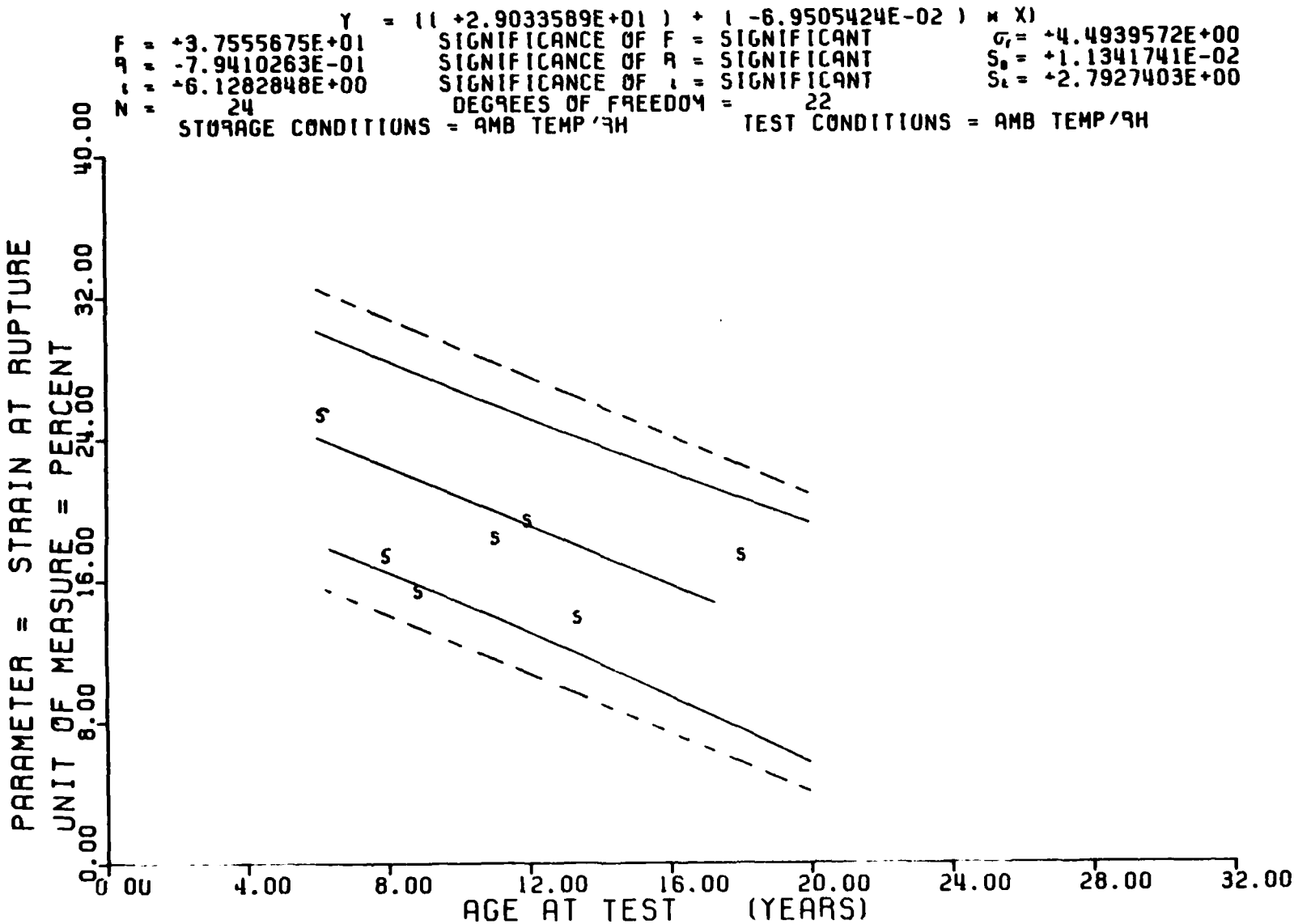

Y = ((+1.6139164E+01) + (+1.5028554E-02) * X)
F = +1.5693659E+00 SIGNIFICANCE OF F = NOT SIGNIFICANT σr = +1.0327955E+00
R = +5.3083461E-01 SIGNIFICANCE OF R = NOT SIGNIFICANT Sb = +1.1996514E-02
t = +1.2527433E+00 SIGNIFICANCE OF t = NOT SIGNIFICANT St = +9.7858033E-01
N = 6 DEGREES OF FREEDOM = 4
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRAIN AT RUPTURE
UNIT OF MEASURE = PERCENT
24.00
22.00
20.00
18.00
16.00
14.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1,DSSCTD MTR=0012199,CONTANT STRAIN,STRAIN 0.1 INIT & 0.01 EVERY 48 HRS.

Figure 38-A



STAGE 1,DSSCTD MTR=STM-012,CONTANT STRAIN,STRAIN 0.1 INIT & 0.01 EVERY 48 HRS.

Figure 38-B

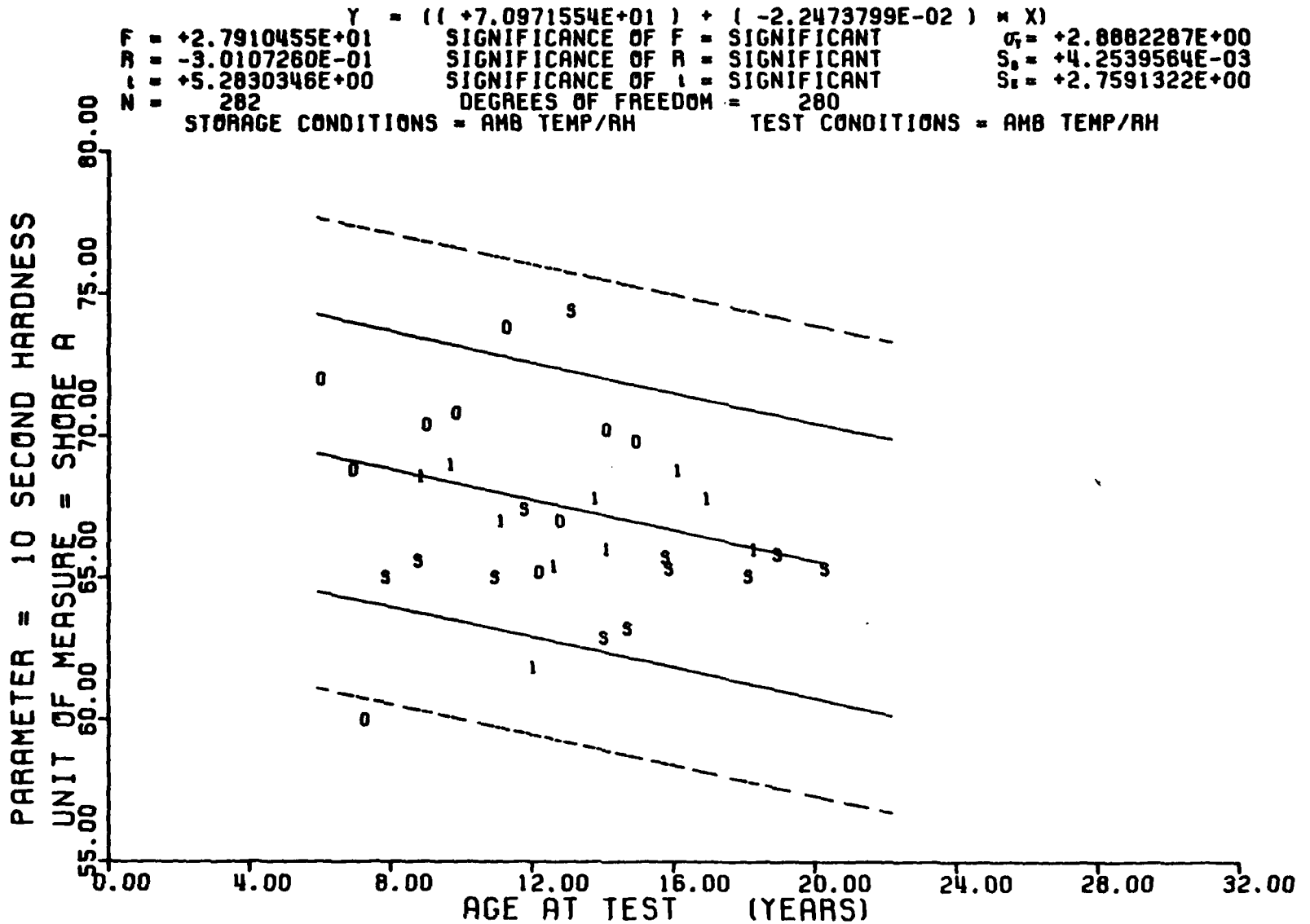

Y = ((+7.0971554E+01) + (-2.2473799E-02) * X)
F = +2.7910455E+01 SIGNIFICANCE OF F = SIGNIFICANT σr = +2.8882287E+00
R = -3.0107260E-01 SIGNIFICANCE OF R = SIGNIFICANT Sb = +4.2539564E-03
t = +5.2830346E+00 SIGNIFICANCE OF t = SIGNIFICANT Sx = +2.7591322E+00
N = 282 DEGREES OF FREEDOM = 280
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = 10 SECOND HARDNESS
UNIT OF MEASURE = SHORE A
80.00
75.00
70.00
65.00
60.00
55.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISCTED MOTORS= (0) 12099, (1) 12199, (S) STM012, HARDNESS, SHORE A 10-SEC.

Figure 39

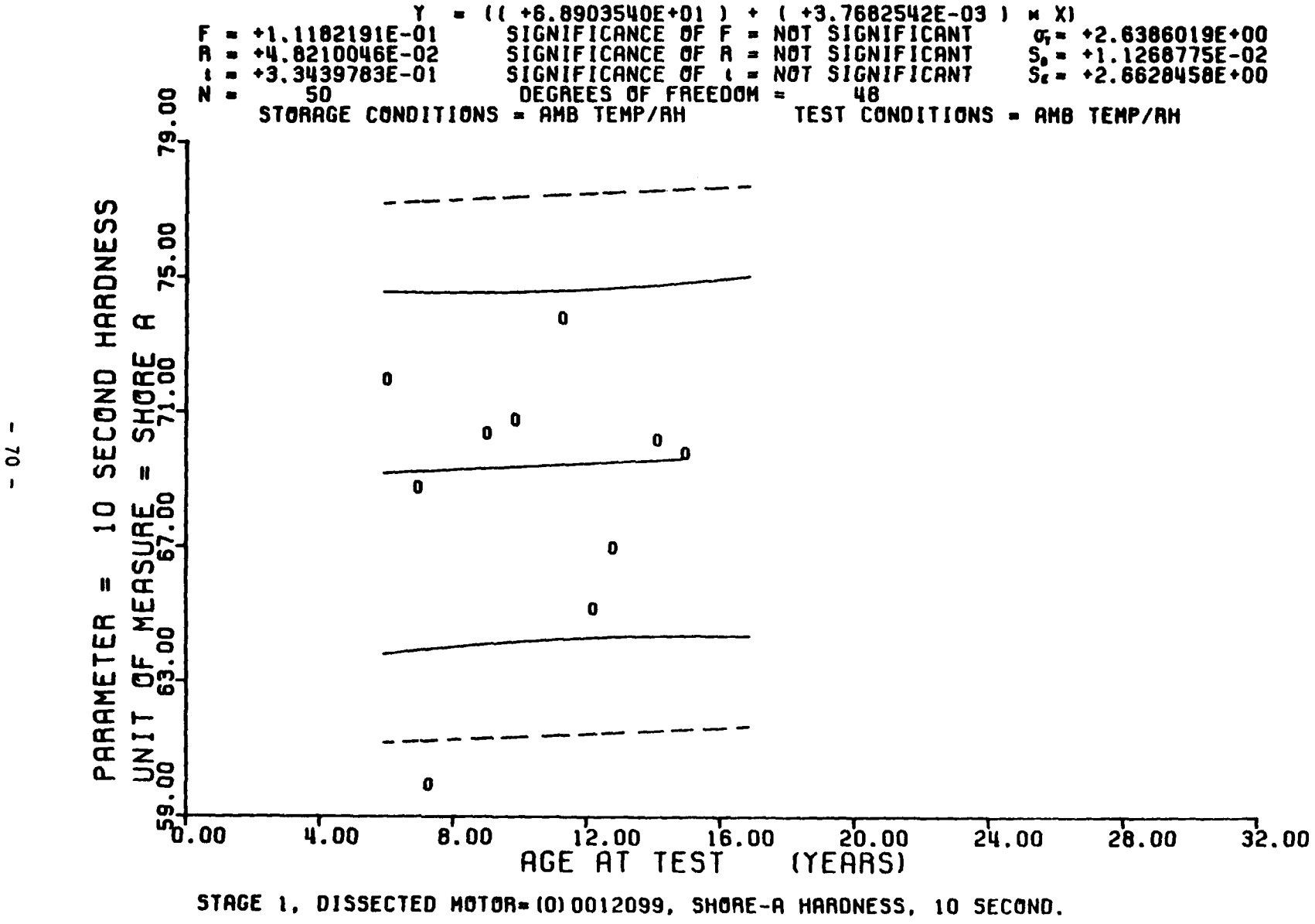
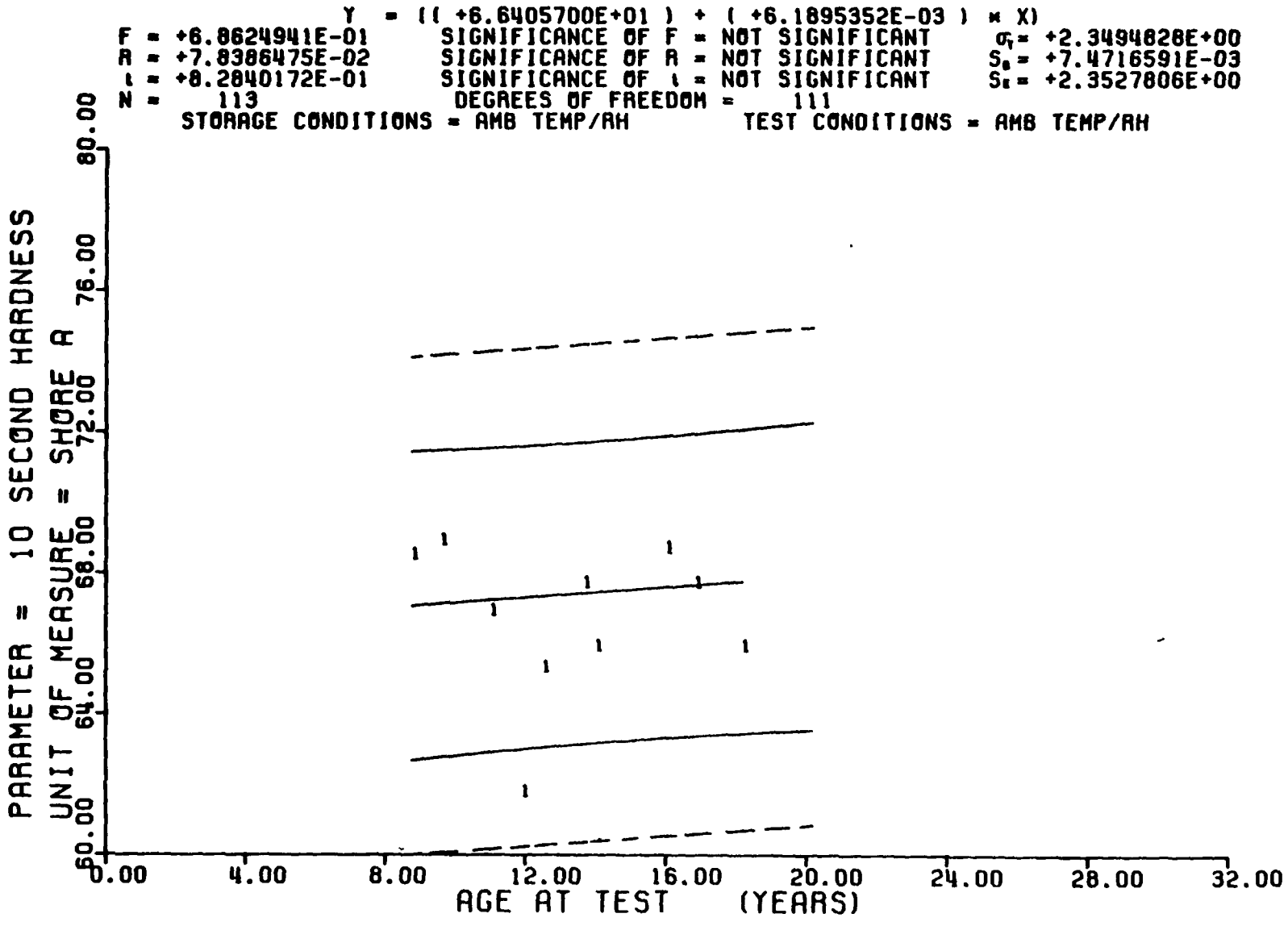
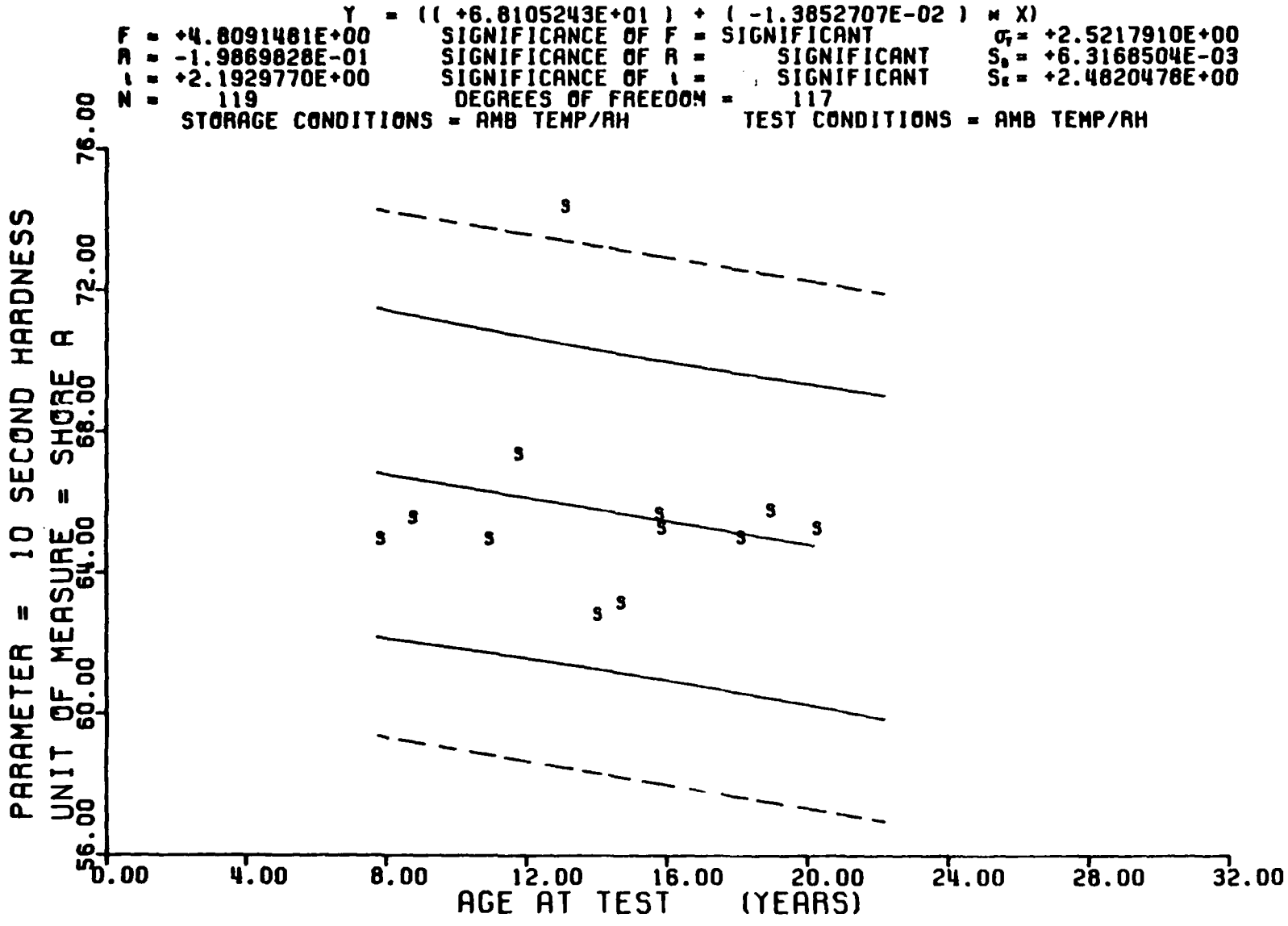

Y = ((+6.8903540E+01) + (+3.7682542E-03) * X)
F = +1.1182191E-01 SIGNIFICANCE OF F = NOT SIGNIFICANT σf = +2.6386019E+00
R = +4.8210046E-02 SIGNIFICANCE OF R = NOT SIGNIFICANT Sb = +1.1268775E-02
t = +3.3439783E-01 SIGNIFICANCE OF t = NOT SIGNIFICANT Se = +2.6628458E+00
N = 50 DEGREES OF FREEDOM = 48
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = 10 SECOND HARDNESS
UNIT OF MEASURE = SHORE A
79.00
75.00
71.00
67.00
63.00
59.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1, DISSECTED MOTOR=(0)0012099, SHORE-A HARDNESS, 10 SECOND.

Figure 39-A



STAGE 1, DISSECTED MOTOR=(1)0012199, SHORE-A HARDNESS, 10 SECOND.

Figure 39-B



STAGE 1, DISSECTED MOTOR=(S)STM-012, SHORE-A HARDNESS, 10 SECOND.

Figure 39-C

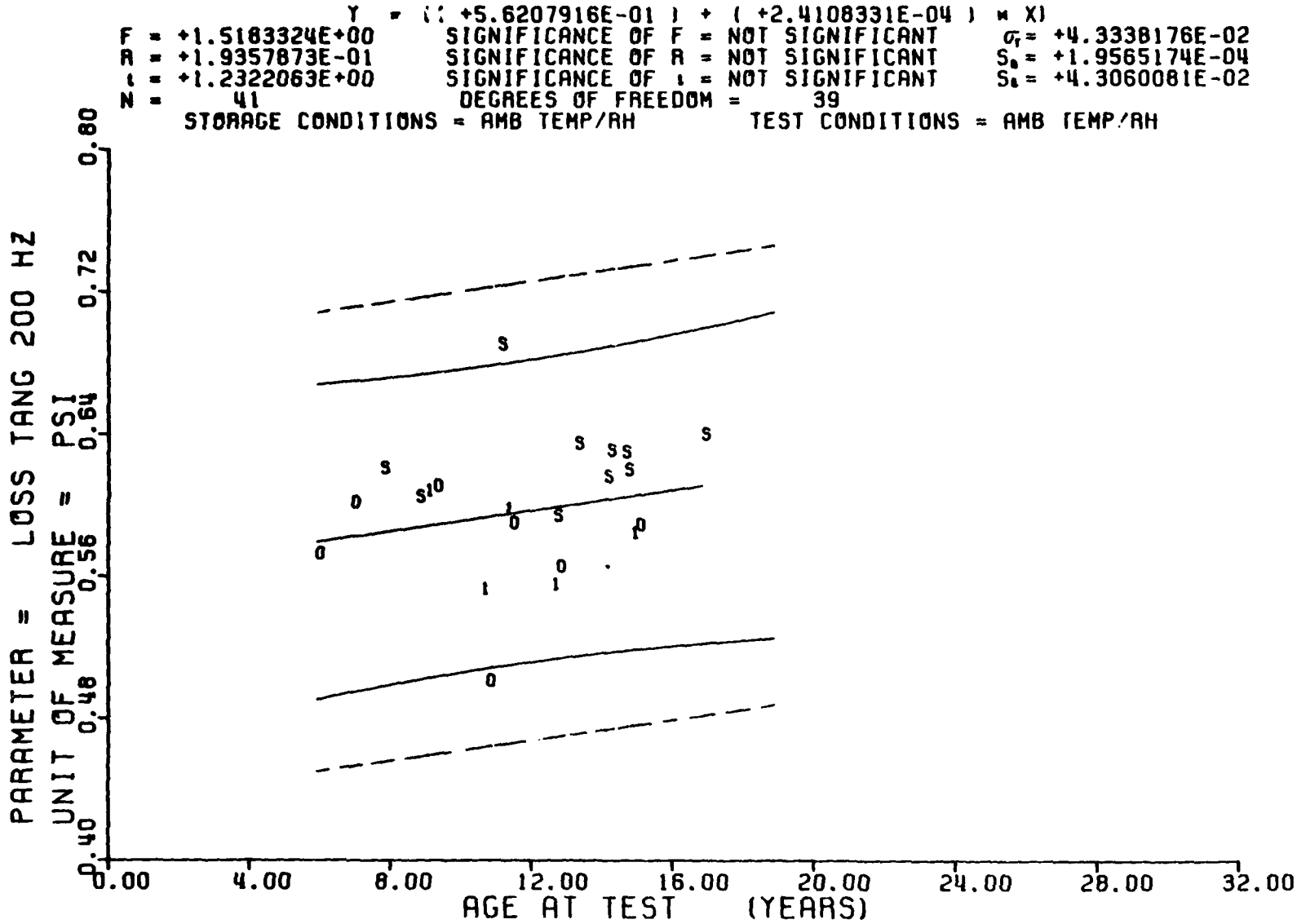

Y = (+5.6207916E-01) + (+2.4108331E-04) * X)
F = +1.5183324E+00 SIGNIFICANCE OF F = NOT SIGNIFICANT σ = +4.3338176E-02
R = +1.9357873E-01 SIGNIFICANCE OF R = NOT SIGNIFICANT S = +1.9565174E-04
t = +1.2322063E+00 SIGNIFICANCE OF t = NOT SIGNIFICANT S = +4.3060081E-02
N = 41 DEGREES OF FREEDOM = 39
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = LOSS TANG 200 HZ
UNIT OF MEASURE = PSI
0.80
0.72
0.64
0.56
0.48
0.40
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE I DISSECTED MOTORS,DYNAMIC RESPONSE,CENTER-WT 70 GM,LOSS TANG AT 200 HZ

Figure 40

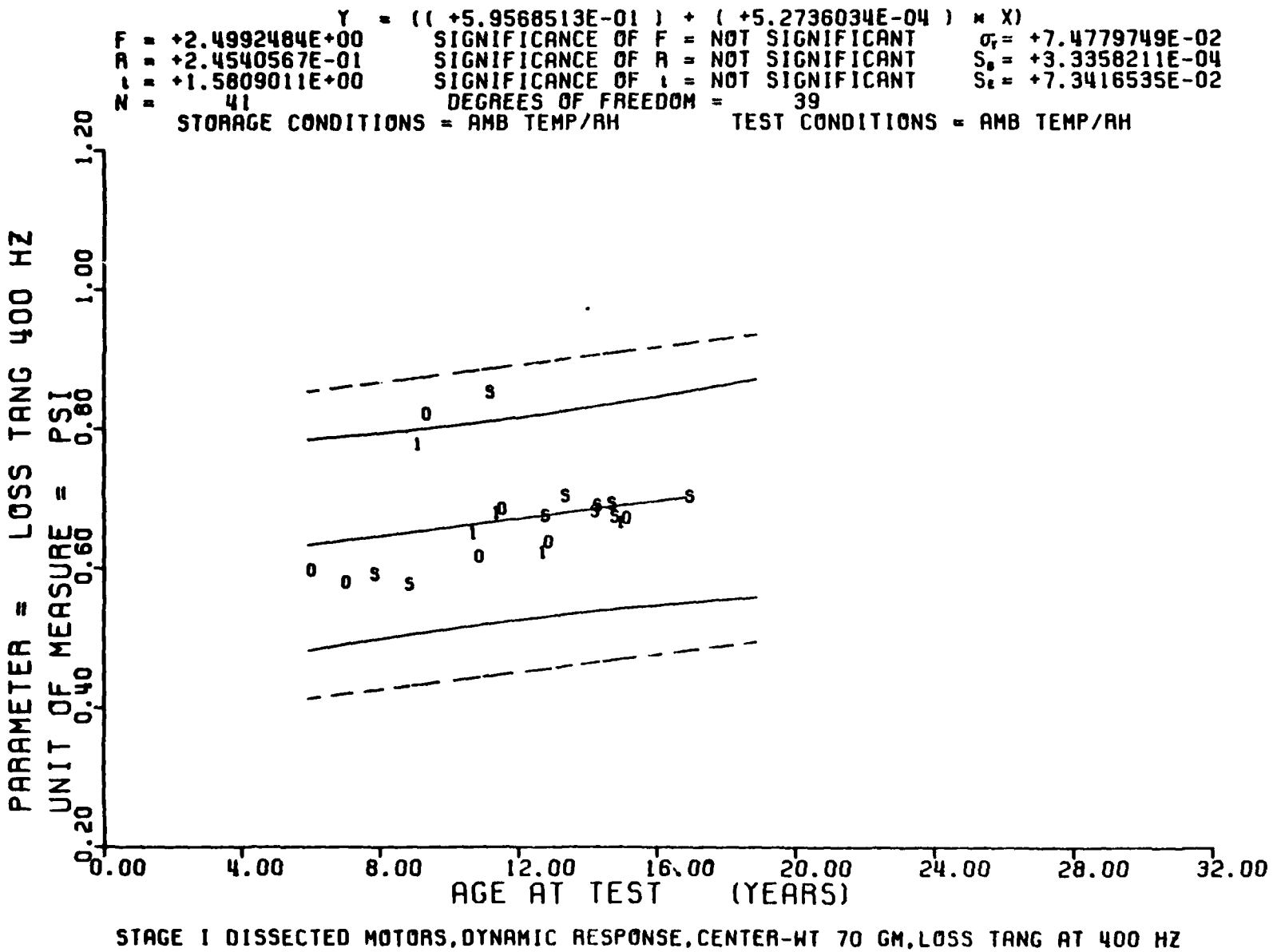
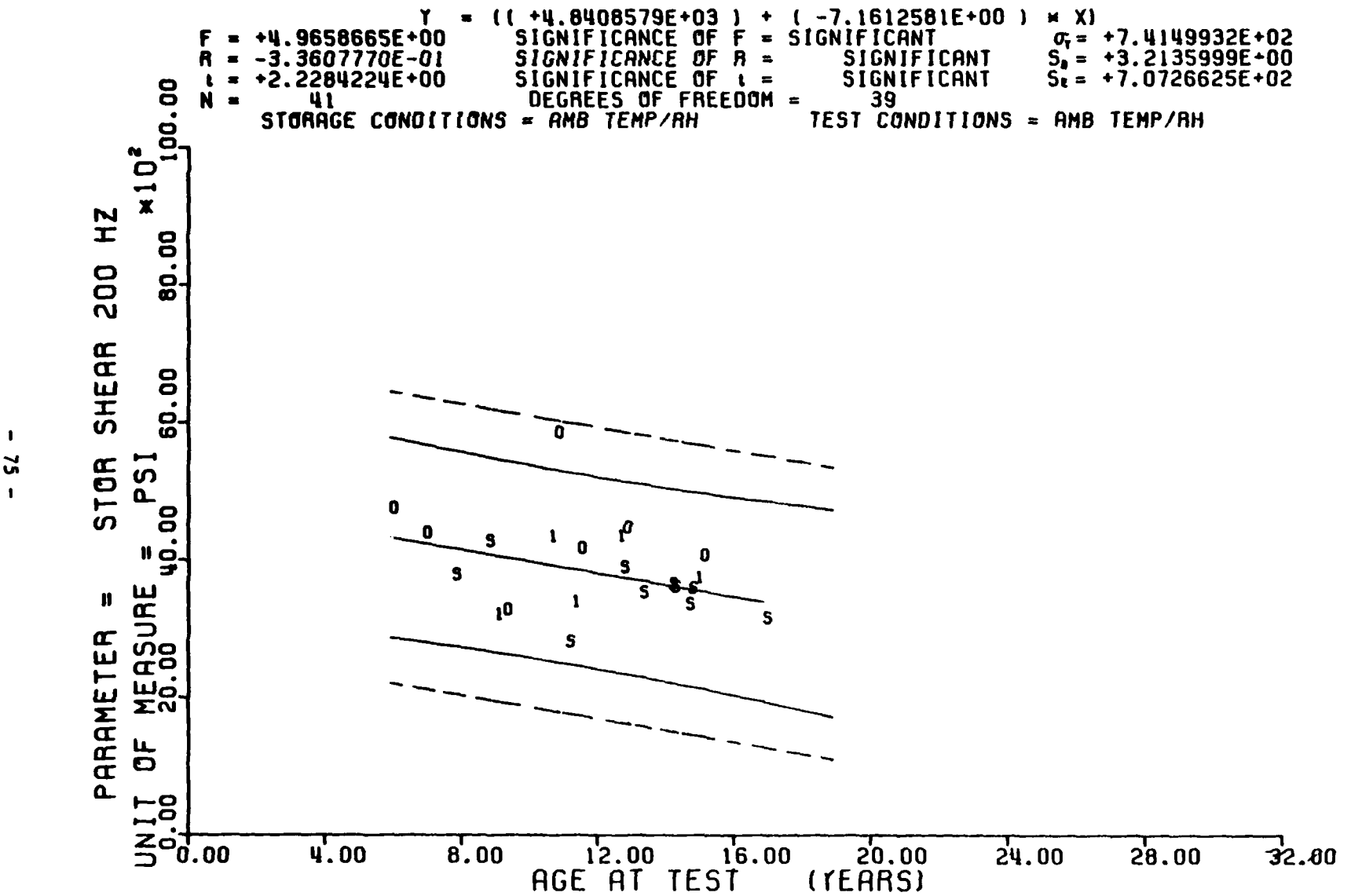
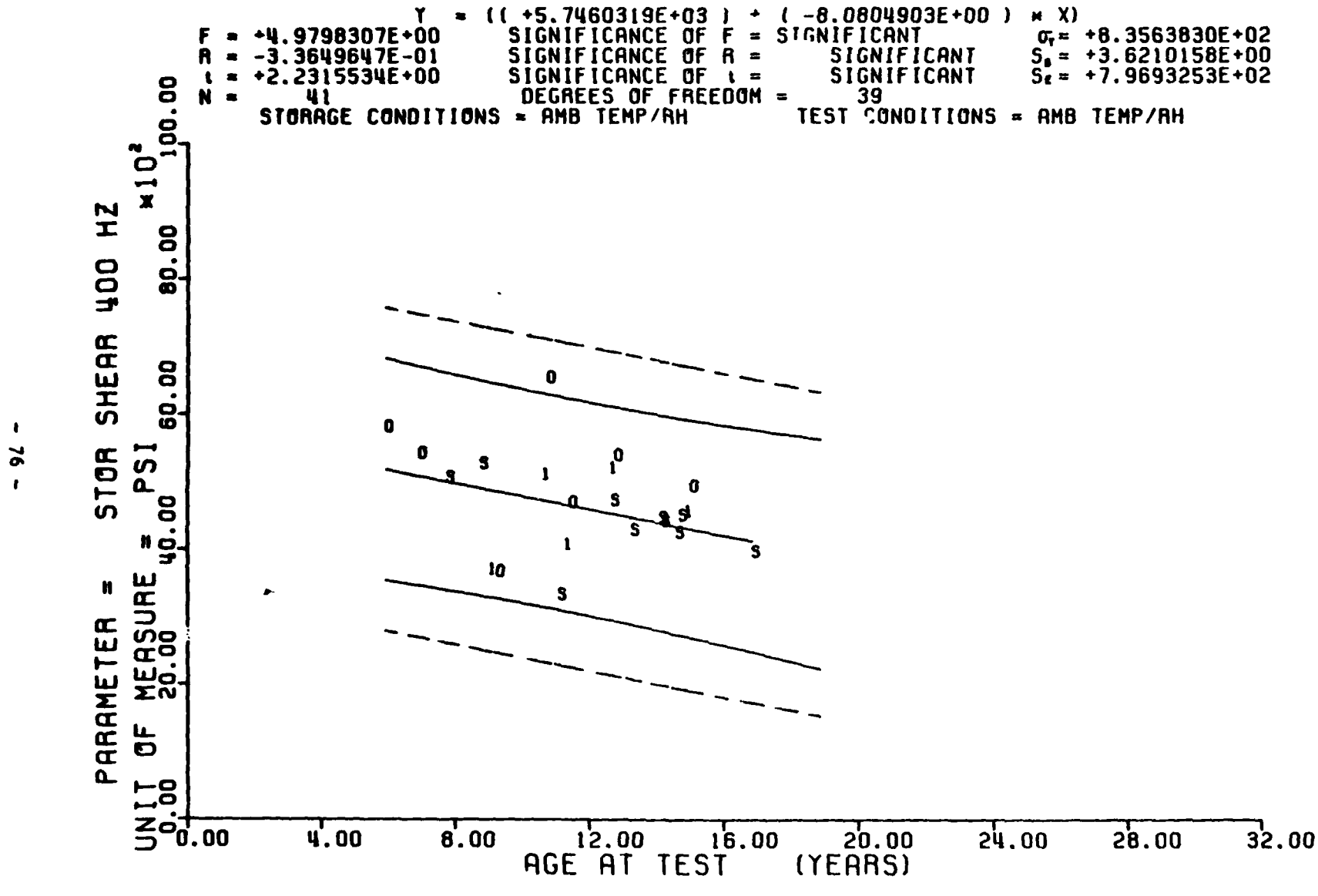

Y = ((+5.9568513E-01) + (+5.2736034E-04) * X)
F = +2.4992484E+00 SIGNIFICANCE OF F = NOT SIGNIFICANT σr = +7.4779749E-02
R = +2.4540567E-01 SIGNIFICANCE OF R = NOT SIGNIFICANT Sb = +3.3358211E-04
t = +1.5809011E+00 SIGNIFICANCE OF t = NOT SIGNIFICANT Se = +7.3416535E-02
N = 41 DEGREES OF FREEDOM = 39
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = LOSS TANG 400 HZ
UNIT OF MEASURE = PSI
1.20
1.00
0.80
0.60
0.40
0.20
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE I DISSECTED MOTORS, DYNAMIC RESPONSE, CENTER-WT 70 GM, LOSS TANG AT 400 HZ

Figure 41



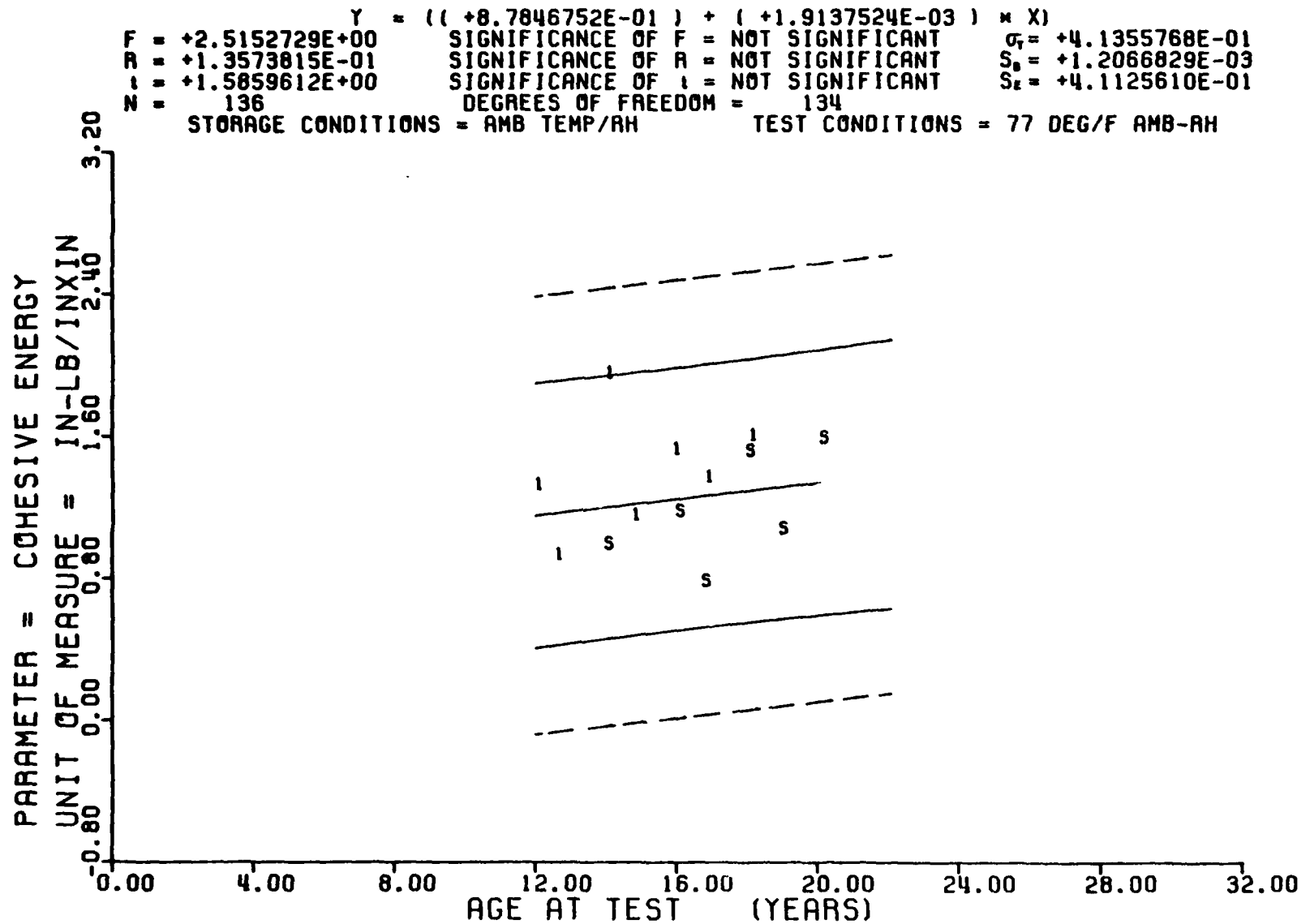
STAGE I DISSECTED MOTORS, DYNAMIC RESPONSE, CENTER-WT 70 GM, STOR SHEAR AT 200 HZ

Figure 42



STAGE I DISSECTED MOTORS, DYNAMIC RESPONSE, CENTER-WT 70 GM, STOR SHEAR AT 400 HZ

Figure 43



STAGE I DISSECTED MOTORS, TEAR ENERGY TEST/TEMP=77 DEG F

Figure 44

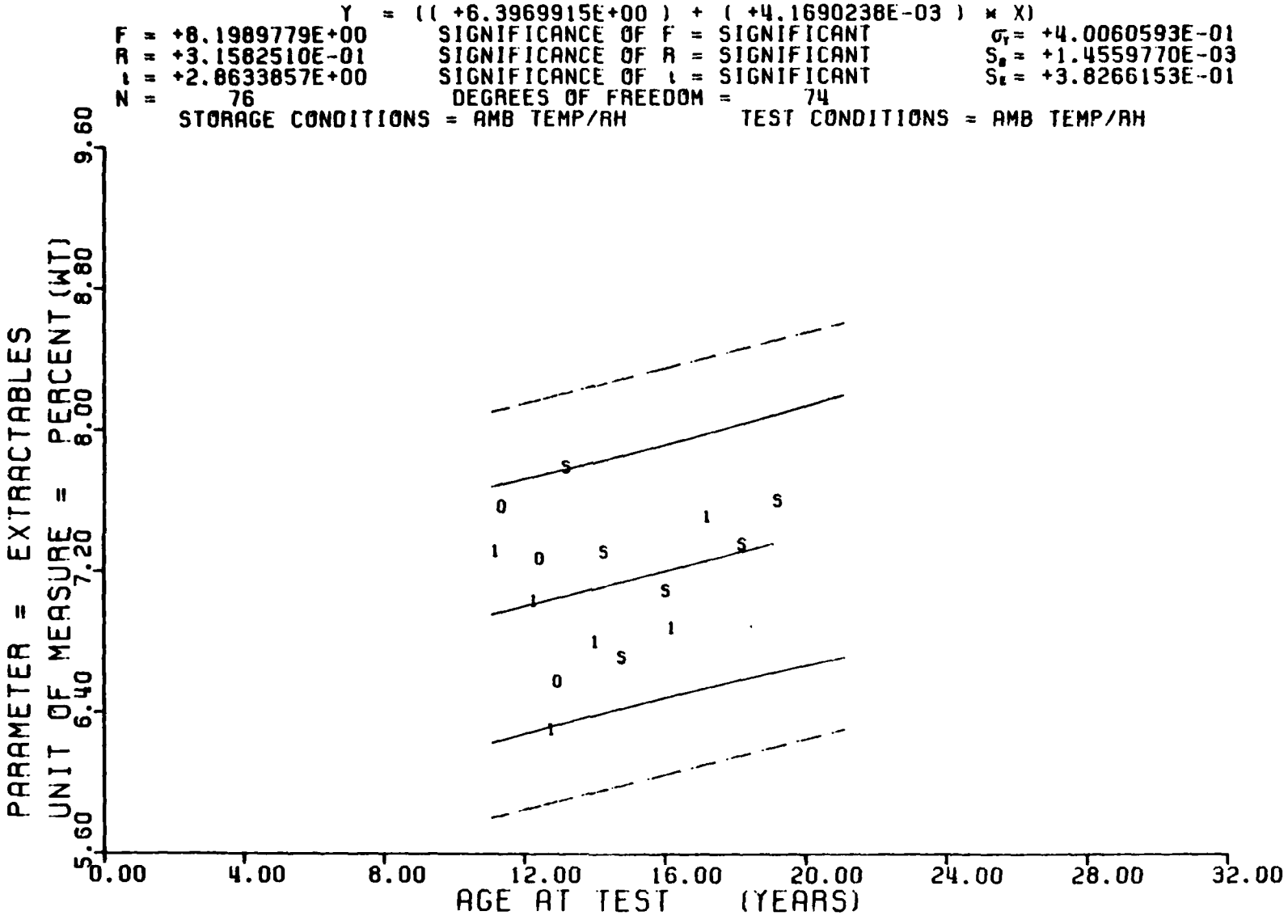

Y = ((+6.3969915E+00) + (+4.1690238E-03) * X)
F = +8.1989779E+00 SIGNIFICANCE OF F = SIGNIFICANT σr = +4.0060593E-01
R = +3.1582510E-01 SIGNIFICANCE OF R = SIGNIFICANT Sa = +1.4559770E-03
t = +2.8633857E+00 SIGNIFICANCE OF t = SIGNIFICANT St = +3.8266153E-01
N = 76 DEGREES OF FREEDOM = 74
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = EXTRACTABLES
UNIT OF MEASURE = PERCENT (WT)
9.60
8.80
8.00
7.20
6.40
5.60
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
DISSECTED MTR, STAGE 1, TP-H1011, SOL GEL, PERCENT EXTRACTABLES

Figure 45

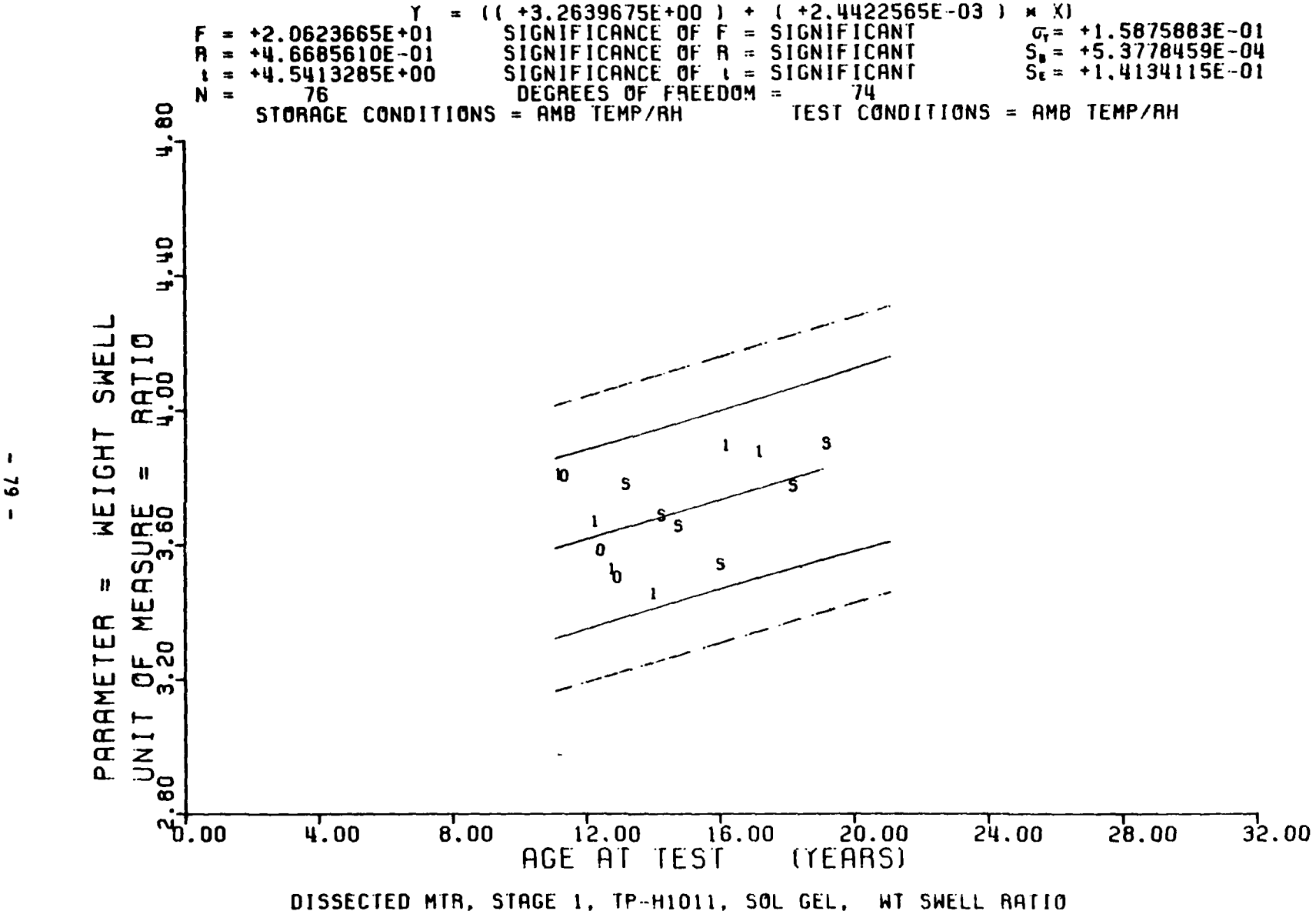

Y = ((+3.2639675E+00) + (+2.4422565E-03) * X)
F = +2.0623665E+01 SIGNIFICANCE OF F = SIGNIFICANT σT = +1.5875883E-01
R = +4.6685610E-01 SIGNIFICANCE OF R = SIGNIFICANT SB = +5.3778459E-04
t = +4.5413285E+00 SIGNIFICANCE OF t = SIGNIFICANT SE = +1.4134115E-01
N = 76 DEGREES OF FREEDOM = 74
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = WEIGHT SWELL
UNIT OF MEASURE = RATIO
4.80
4.40
4.00
3.60
3.20
2.80
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
DISSECTED MTR, STAGE 1, TP-H1011, SOL GEL, WT SWELL RATIO

Figure 46

Y = ((+1.7899702E+00) + (-1.1621495E-04) * X)

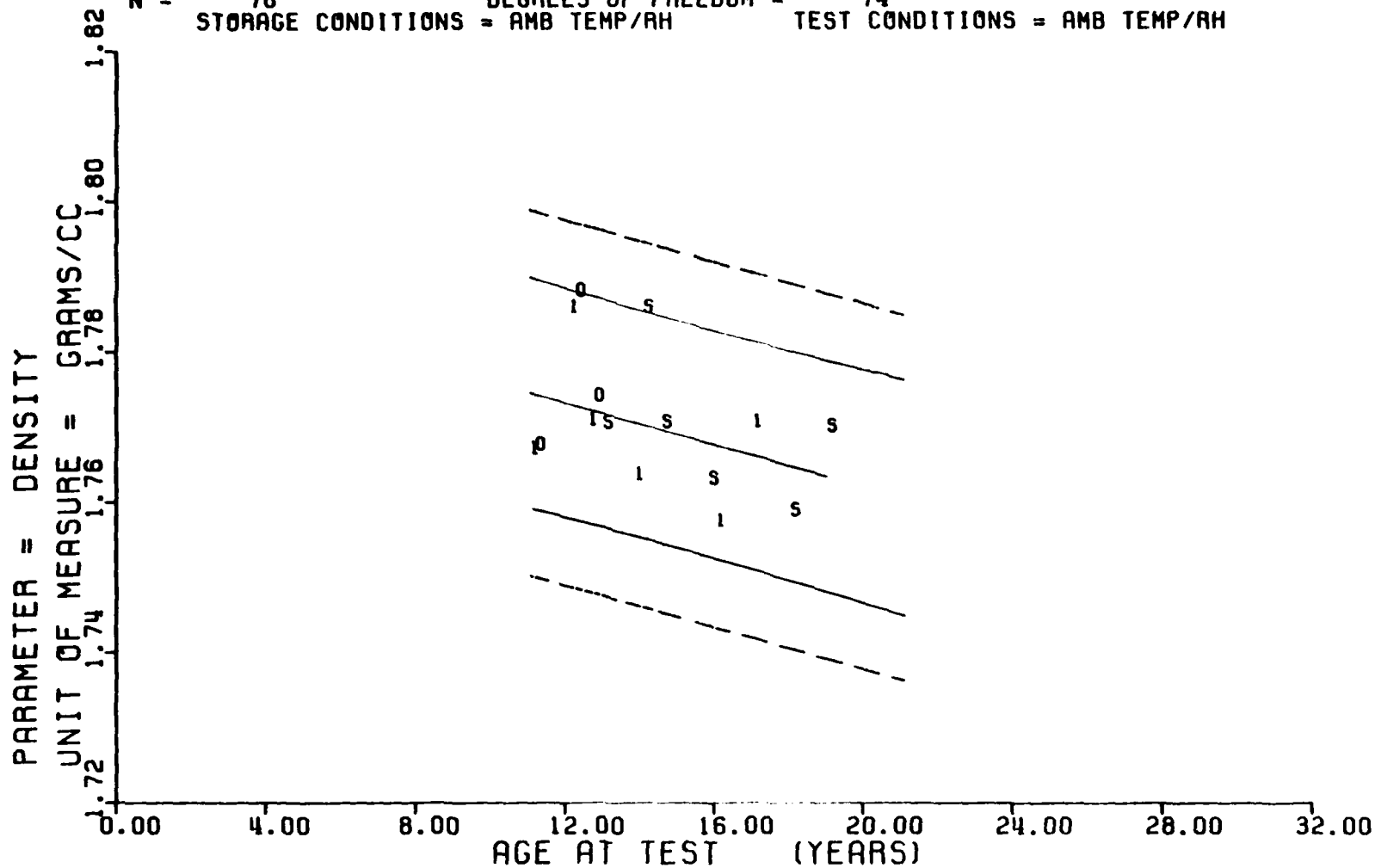
F = +1.4213338E+01 SIGNIFICANCE OF F = SIGNIFICANT σ_r = +8.7863957E-03

R = -4.0140327E-01 SIGNIFICANCE OF R = SIGNIFICANT S_e = +3.0825773E-05

t = +3.7700581E+00 SIGNIFICANCE OF t = SIGNIFICANT S_t = +8.1016647E-03

N = 76 DEGREES OF FREEDOM = 74

STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH



STAGE 1, DISSECTED MTRS= (0) 0012099, (1) 0012199, (S) STM-012, SOL GEL DENSITY.

Figure 47

Y = ((+1.4295726E-02) + (-1.9675902E-05) * X)

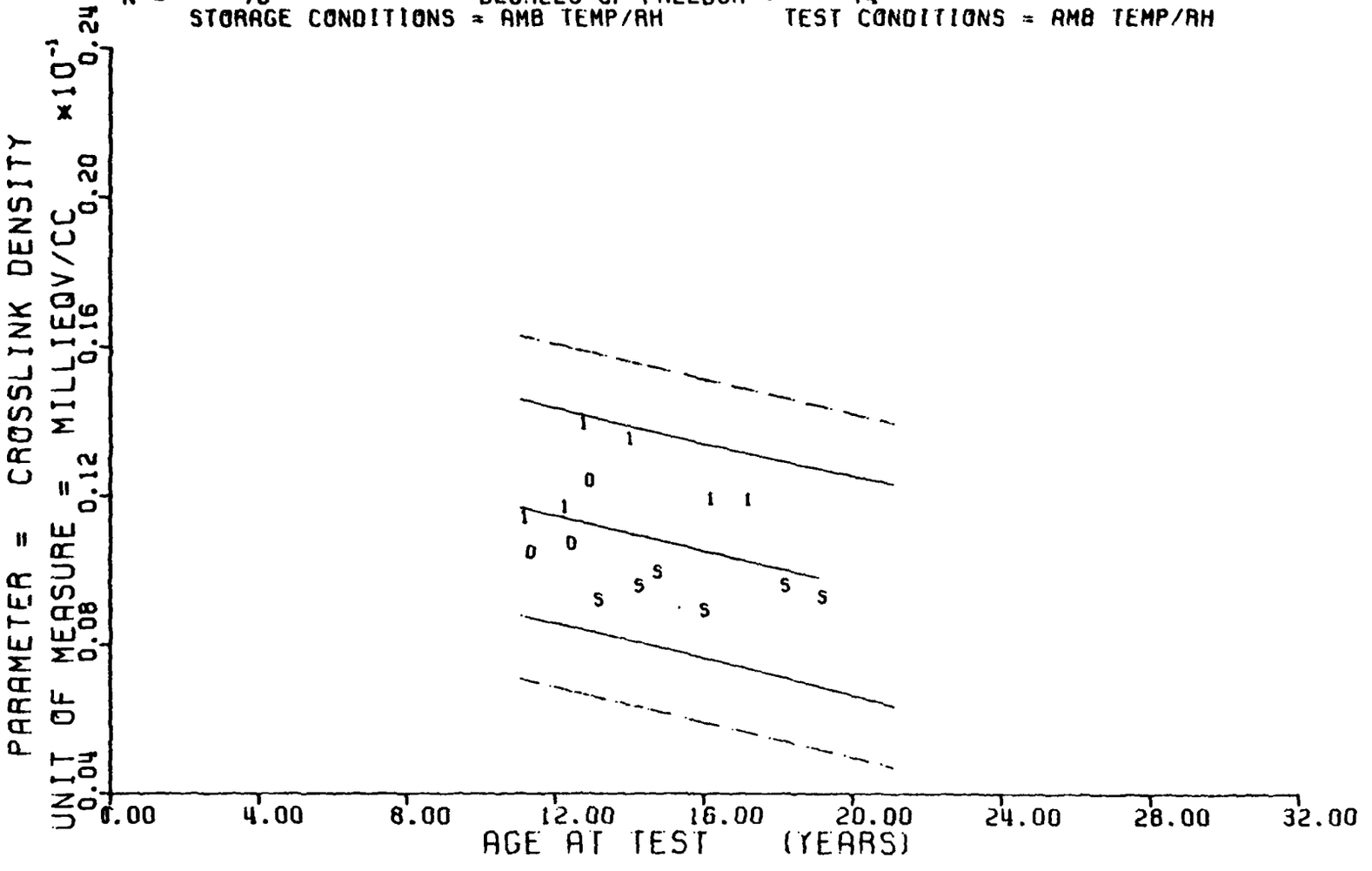
F = +1.1336245E+01 SIGNIFICANCE OF F = SIGNIFICANT σ_Y = +1.6383114E-03

R = -3.6447509E-01 SIGNIFICANCE OF R = SIGNIFICANT S_θ = +5.8438632E-06

ι = +3.3669341E+00 SIGNIFICANCE OF ι = SIGNIFICANT S_ε = +1.5358907E-03

N = 76 DEGREES OF FREEDOM = 74

STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH



DISSECTED MTR, STAGE 1, TP-H1011, SOL GEL, CROSSLINK DENSITY

Figure 48

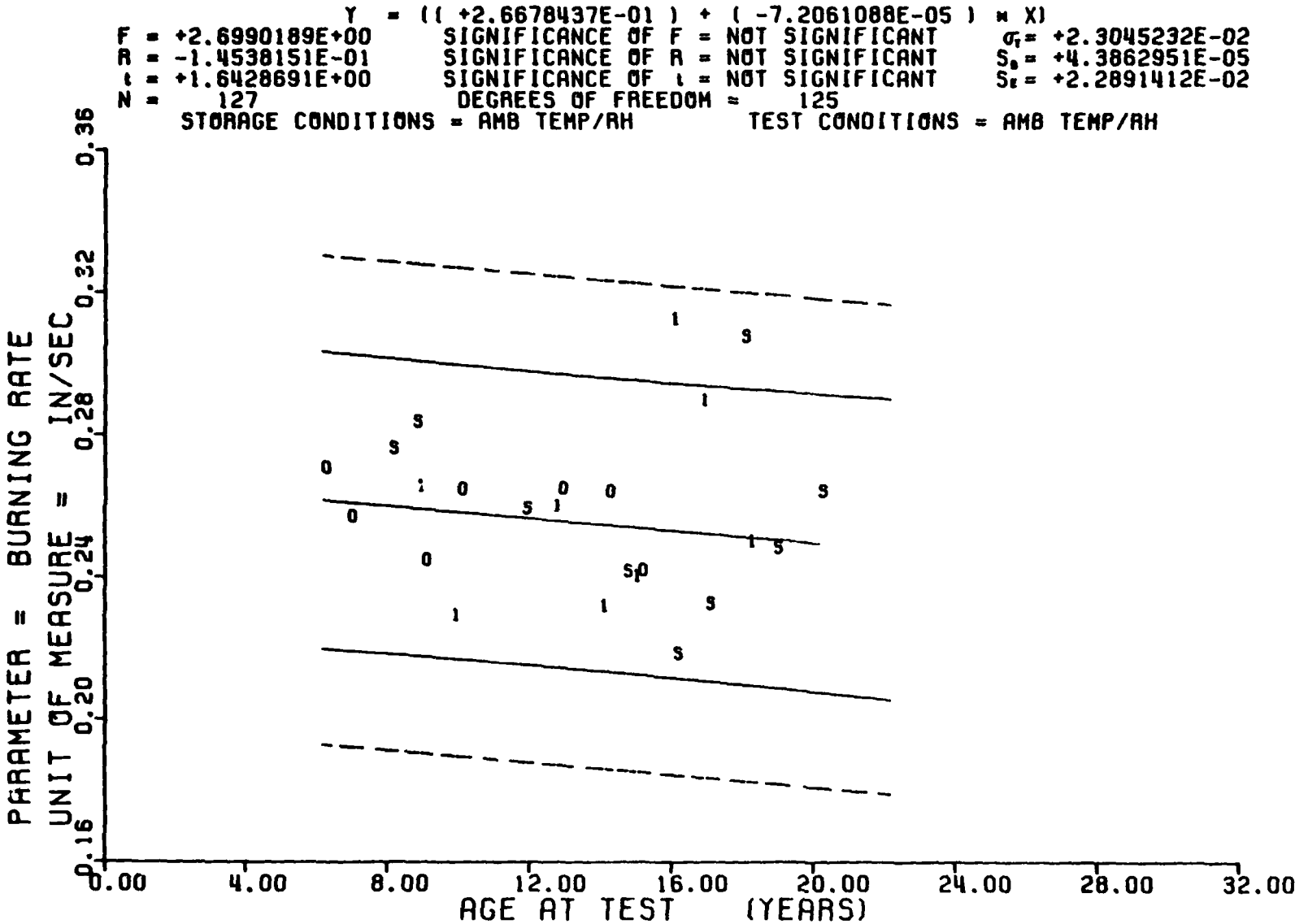
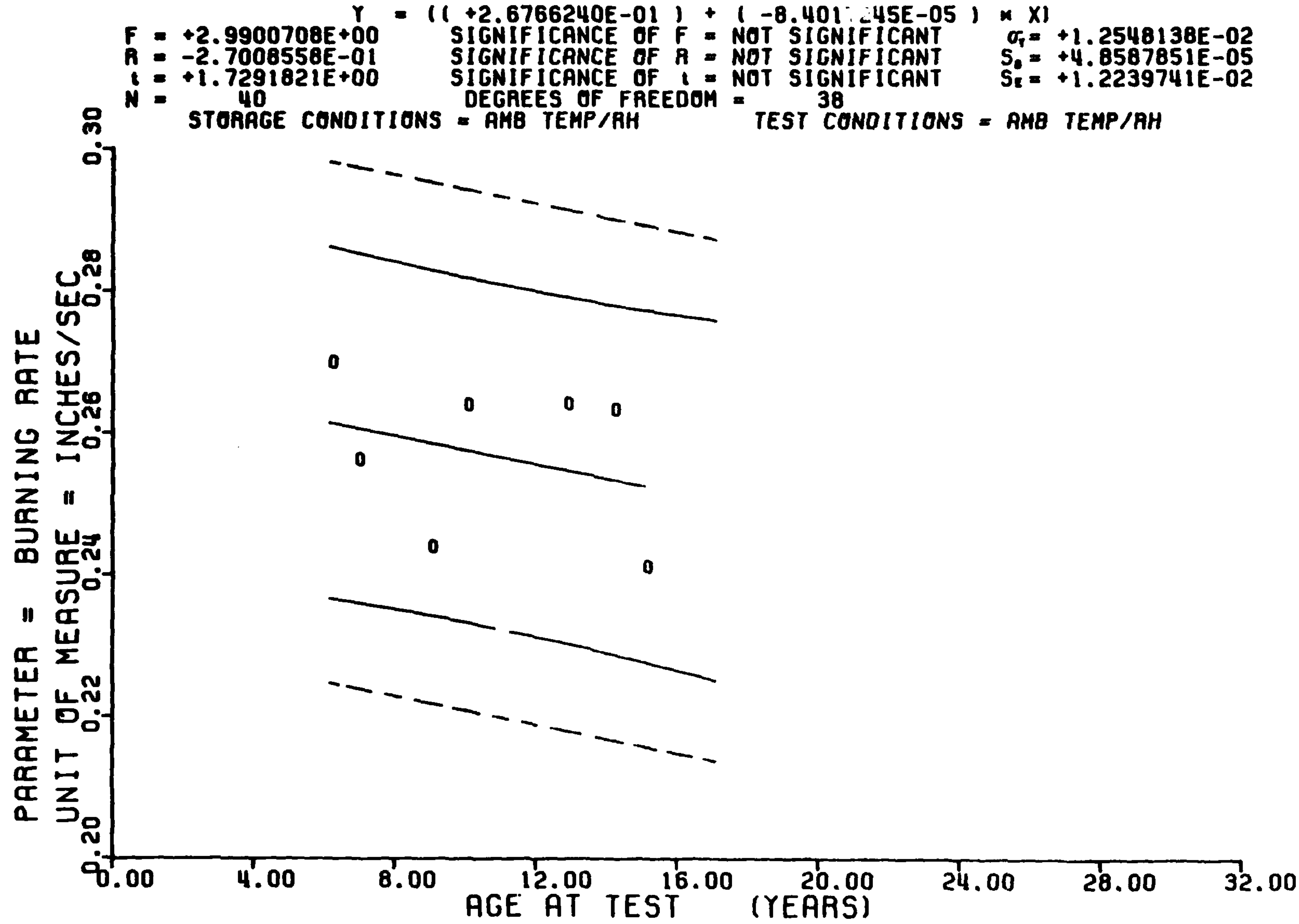

Y = ((+2.6678437E-01) + (-7.2061088E-05) * X)
F = +2.6990189E+00 SIGNIFICANCE OF F = NOT SIGNIFICANT σt = +2.3045232E-02
R = -1.4538151E-01 SIGNIFICANCE OF R = NOT SIGNIFICANT Sb = +4.3862951E-05
t = +1.6428691E+00 SIGNIFICANCE OF t = NOT SIGNIFICANT Se = +2.2891412E-02
N = 127 DEGREES OF FREEDOM = 125
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = BURNING RATE
UNIT OF MEASURE = IN/SEC
0.36
0.32
0.28
0.24
0.20
0.16
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISCTED MTRS= (0) 0012099, (1) 0012199, (S) STM-012, BURNING RATE AT 500 PSI.

Figure 49



STAGE 1,DISSECTED MOTOR=(0)0012099,BURNING RATE AT 500 PSI INITIAL PRESSURE.

Figure 49=A

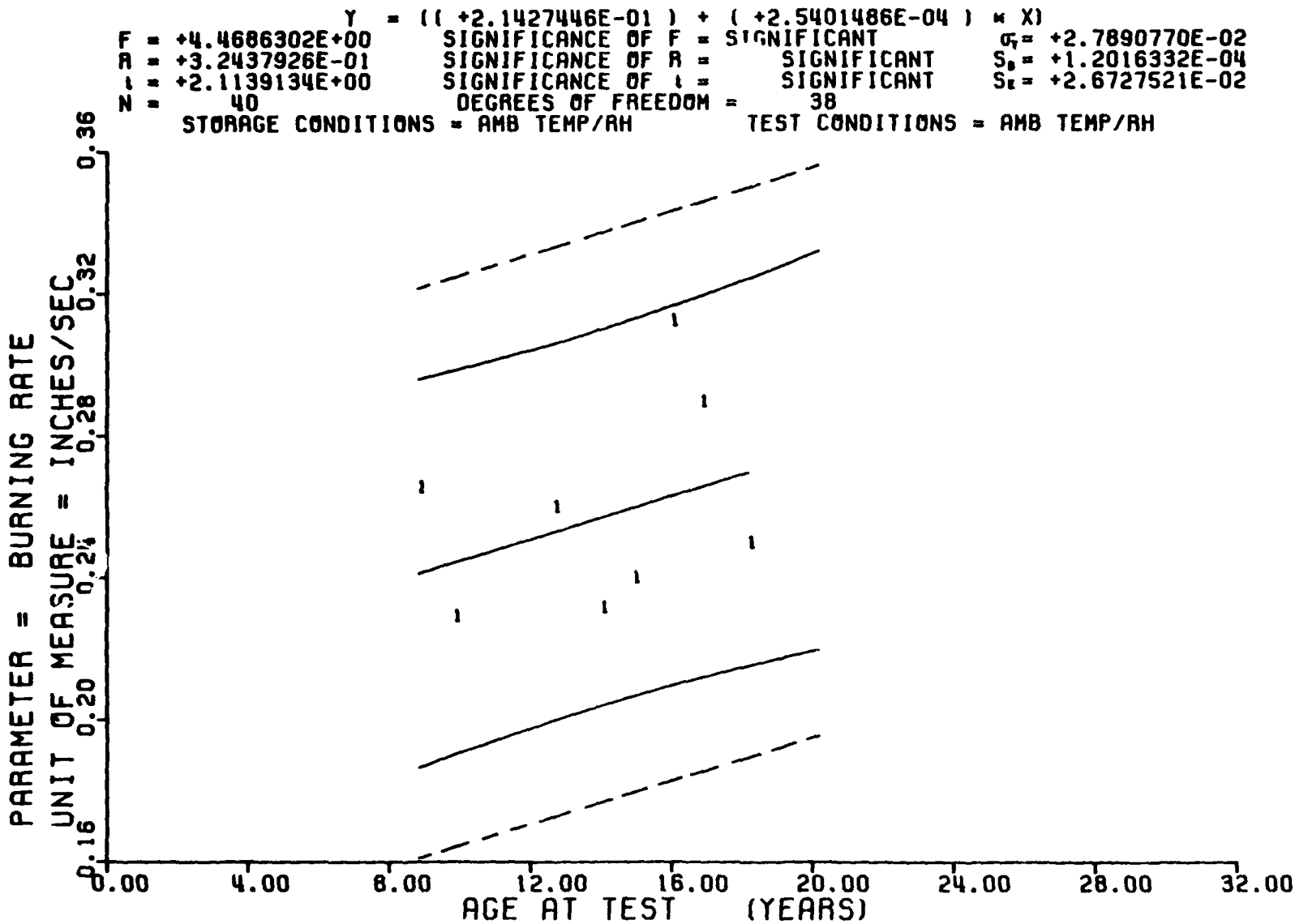
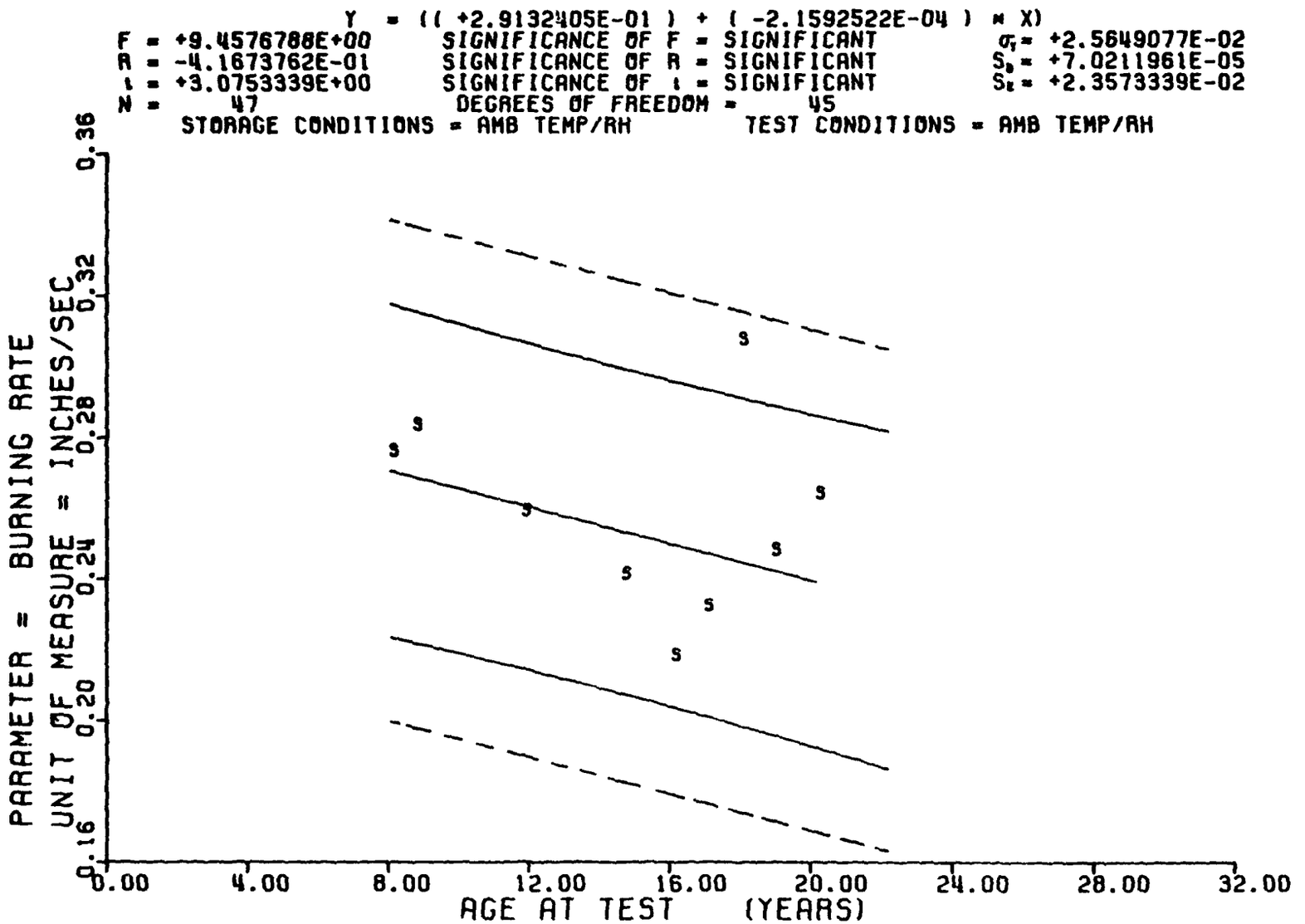

Y = ((+2.1427446E-01) + (+2.5401486E-04) * X)
F = +4.4686302E+00 SIGNIFICANCE OF F = SIGNIFICANT σ = +2.7890770E-02
R = +3.2437926E-01 SIGNIFICANCE OF R = SIGNIFICANT Sb = +1.2016332E-04
t = +2.1139134E+00 SIGNIFICANCE OF t = SIGNIFICANT St = +2.6727521E-02
N = 40 DEGREES OF FREEDOM = 38
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = BURNING RATE
UNIT OF MEASURE = INCHES/SEC
0.36
0.32
0.28
0.24
0.20
0.16
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1,DISSECTED MOTOR=(1)0012199,BURNING RATE AT 500 PSI INITIAL PRESSURE.

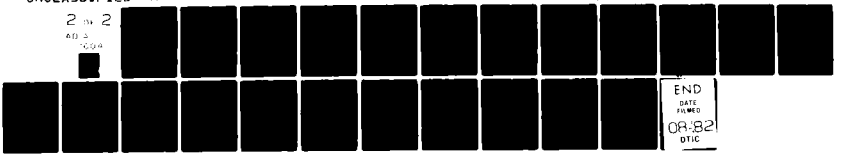
Figure 49-B

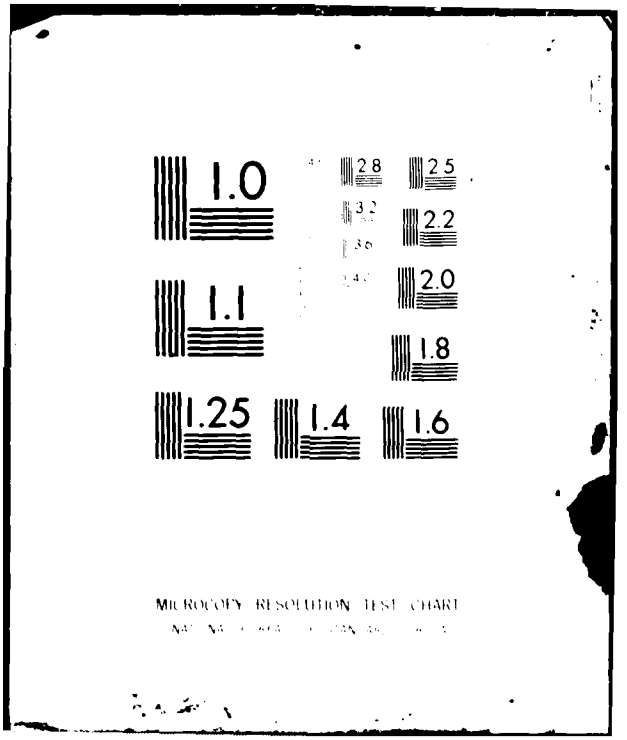


STAGE 1, DISSECTED MOTOR= (S) STM-012, BURNING RATE AT 500 PSI INITIAL PRESSURE.

Figure 49-C

AD-A117 604 OGDEN AIR LOGISTICS CENTER HILL AFB UT PROPELLANT AN--ETC F/G 21/9.2
SURVEILLANCE REPORT. STAGE I DISSECTED MOTORS. PHASE XIII. PROP--ETC(U)
MAY 82 J A THOMPSON
UNCLASSIFIED MANPA-NR-470(82) NL




1.0
2.8
2.5
3.2
2.2
3.6
2.0
1.1
1.8
1.25
1.4
1.6
MICROCOPY RESOLUTION TEST CHART

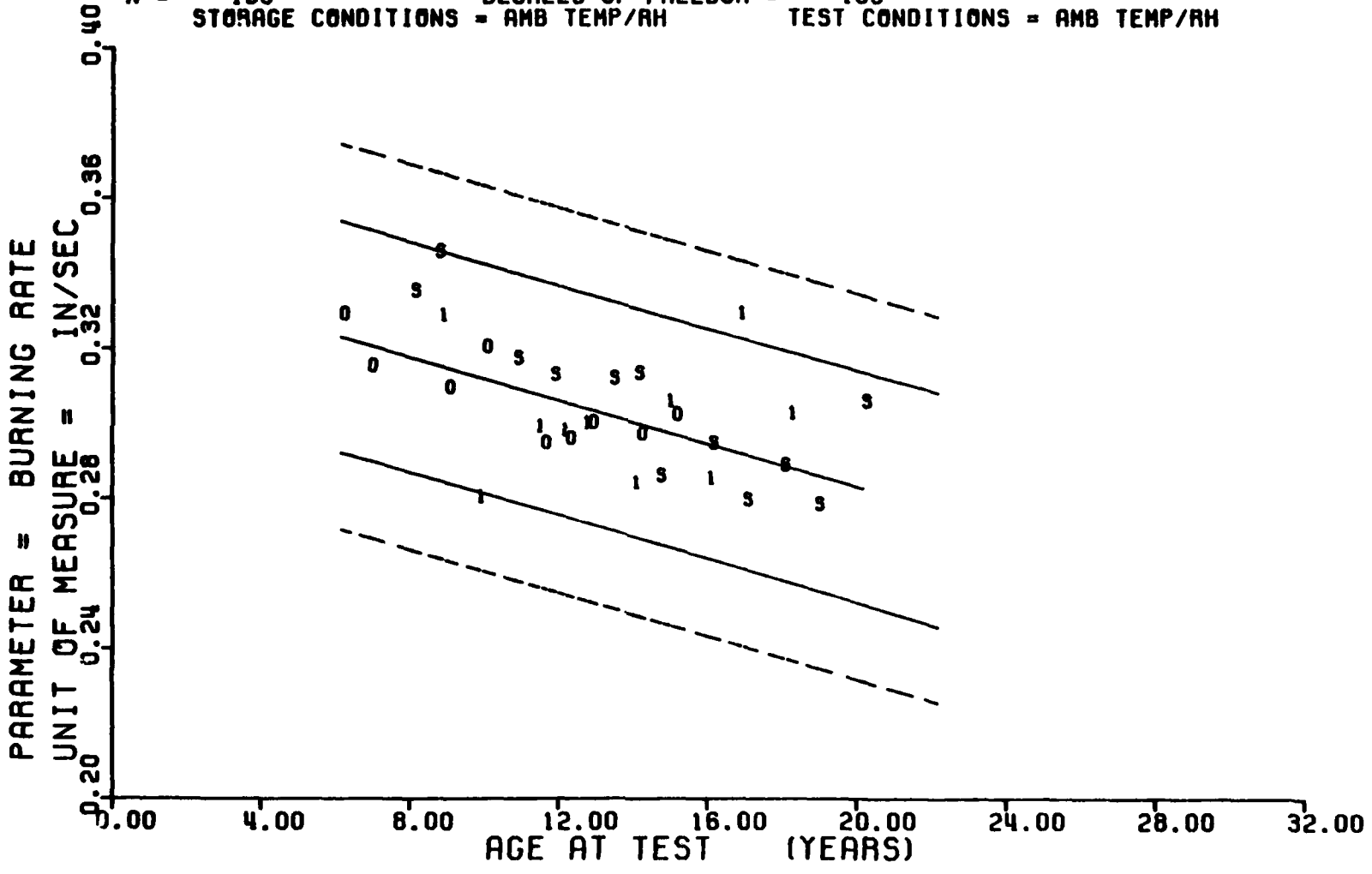
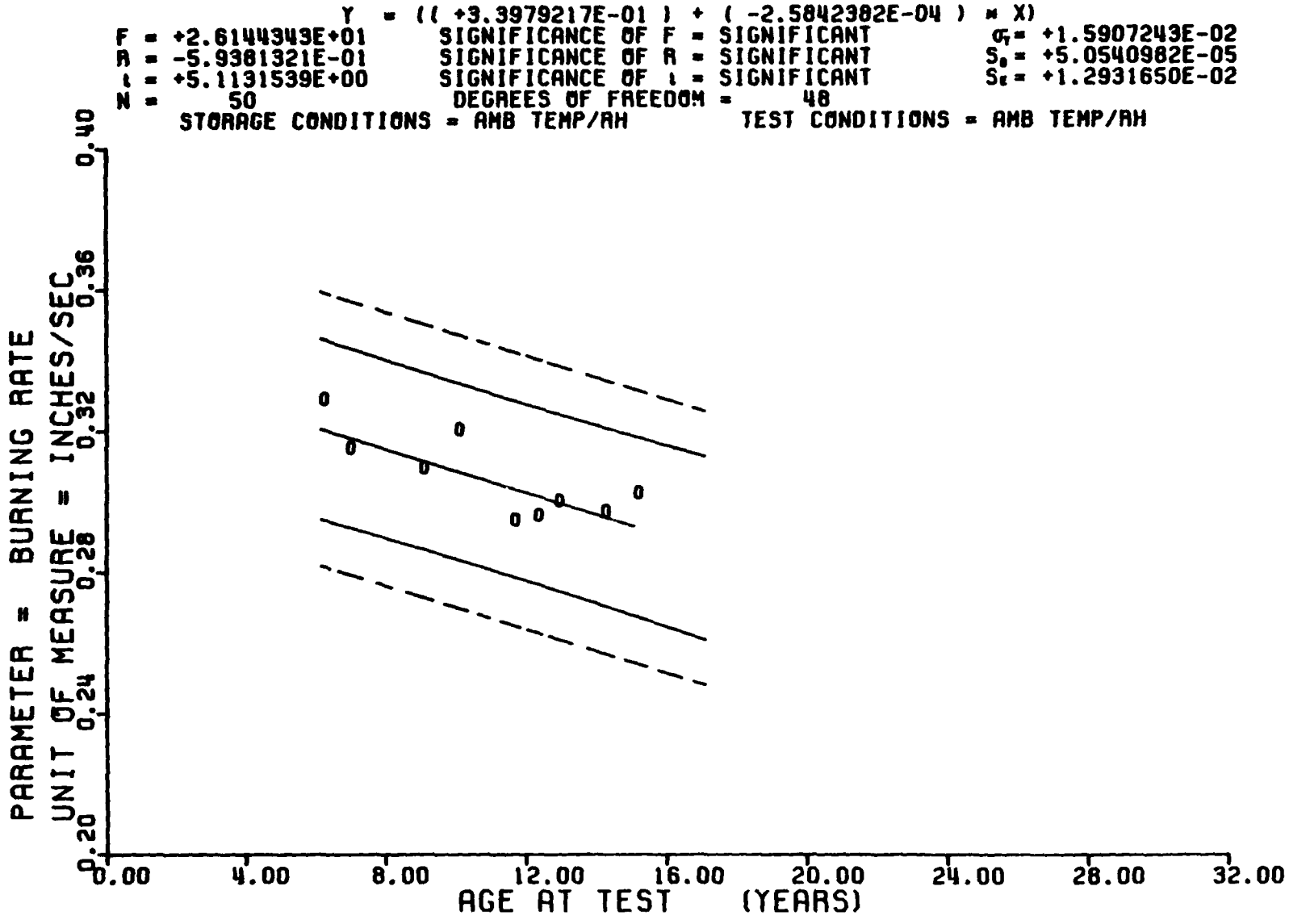

Y = ((+3.4059806E-01) + (-2.3969419E-04) * X)
F = +5.5137556E+01 SIGNIFICANCE OF F = SIGNIFICANT σT = +1.9736404E-02
R = -5.0275747E-01 SIGNIFICANCE OF R = SIGNIFICANT Sb = +3.2280016E-05
t = +7.4254667E+00 SIGNIFICANCE OF t = SIGNIFICANT Sε = +1.7112944E-02
N = 165 DEGREES OF FREEDOM = 163
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = BURNING RATE
UNIT OF MEASURE = IN/SEC
0.40
0.36
0.32
0.28
0.24
0.20
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISCTED MTRS= (0) 0012099, (1) 0012199, (S) STM-012, BURNING RATE AT 1000 PSI.

Figure 50



STAGE 1, DISSECTED MOTOR= (0) 0012099, BURNING RATE AT 1000 PSI INITIAL PRESSURE.

Figure 50-A

Y = ((+2.9137407E-01) + (+5.9303915E-05) * X)

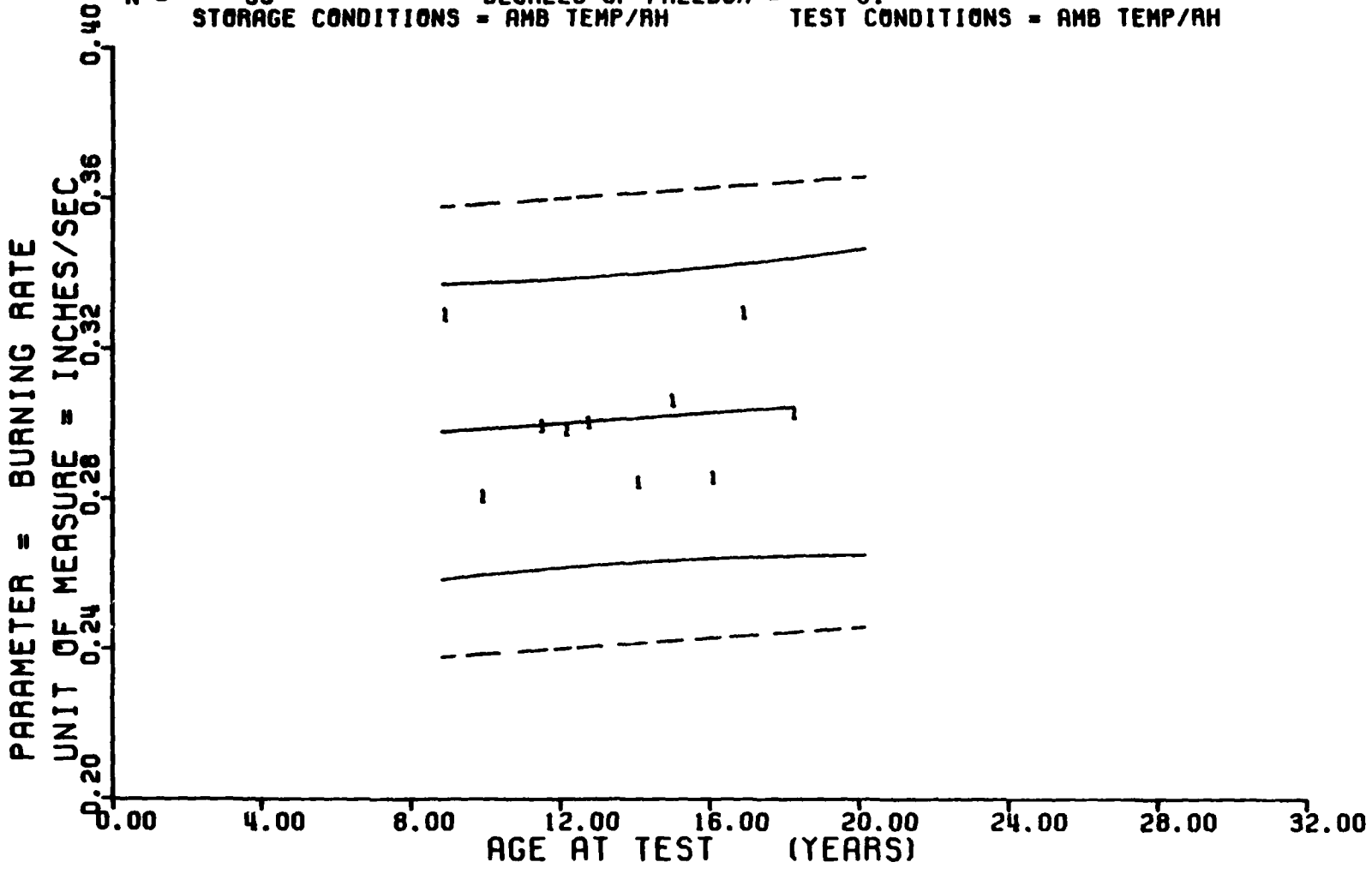
F = +4.8831026E-01 SIGNIFICANCE OF F = NOT SIGNIFICANT σ_Y = +1.9871562E-02

R = +9.7385345E-02 SIGNIFICANCE OF R = NOT SIGNIFICANT S_B = +8.4866333E-05

t = +6.9879200E-01 SIGNIFICANCE OF t = NOT SIGNIFICANT S_E = +1.9970059E-02

N = 53 DEGREES OF FREEDOM = 51

STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH



STAGE 1,DISSECTED MOTOR=(1)0012199,BURNING RATE AT 1000 PSI INITIAL PRESSURE.

Figure 50-B

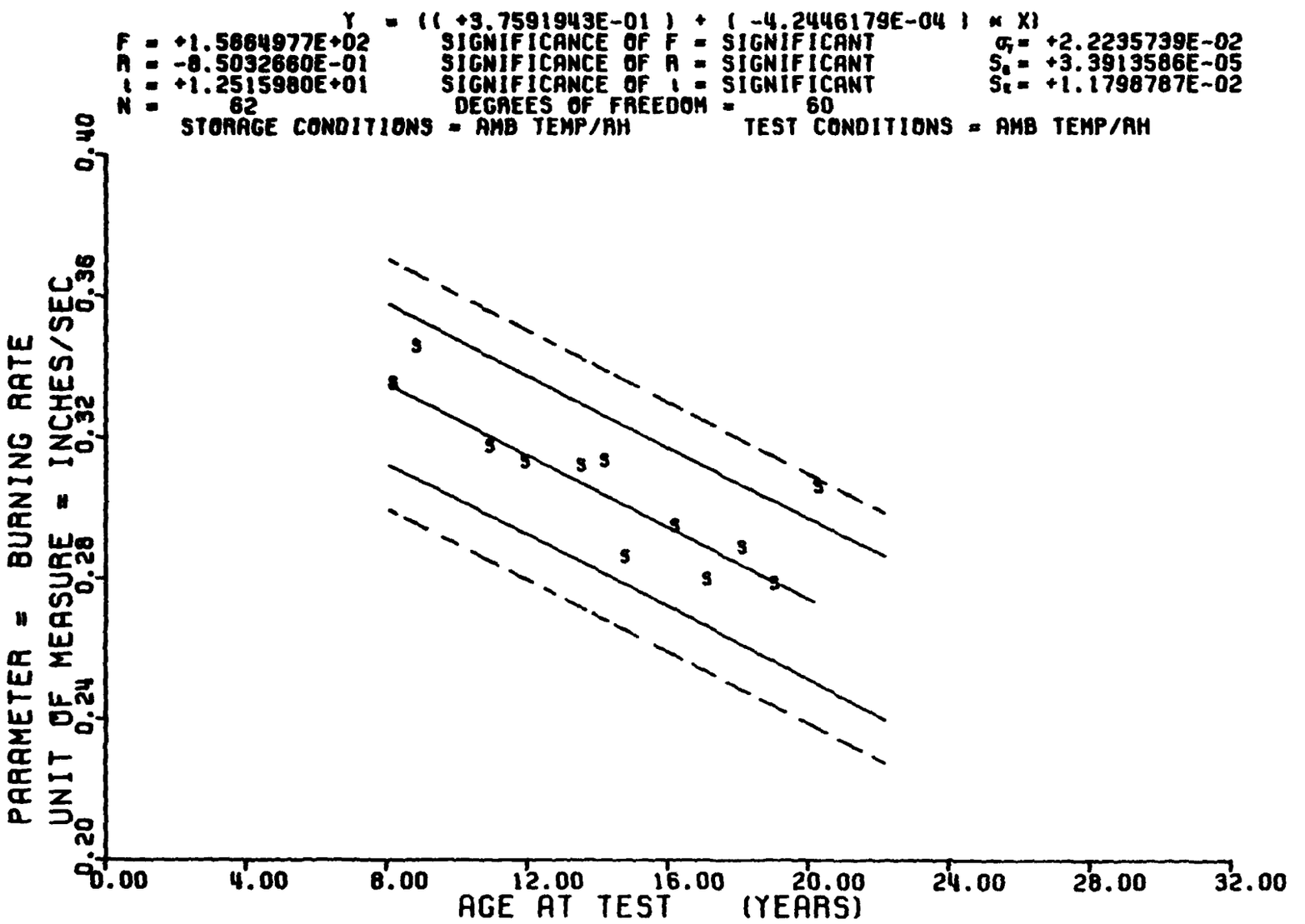
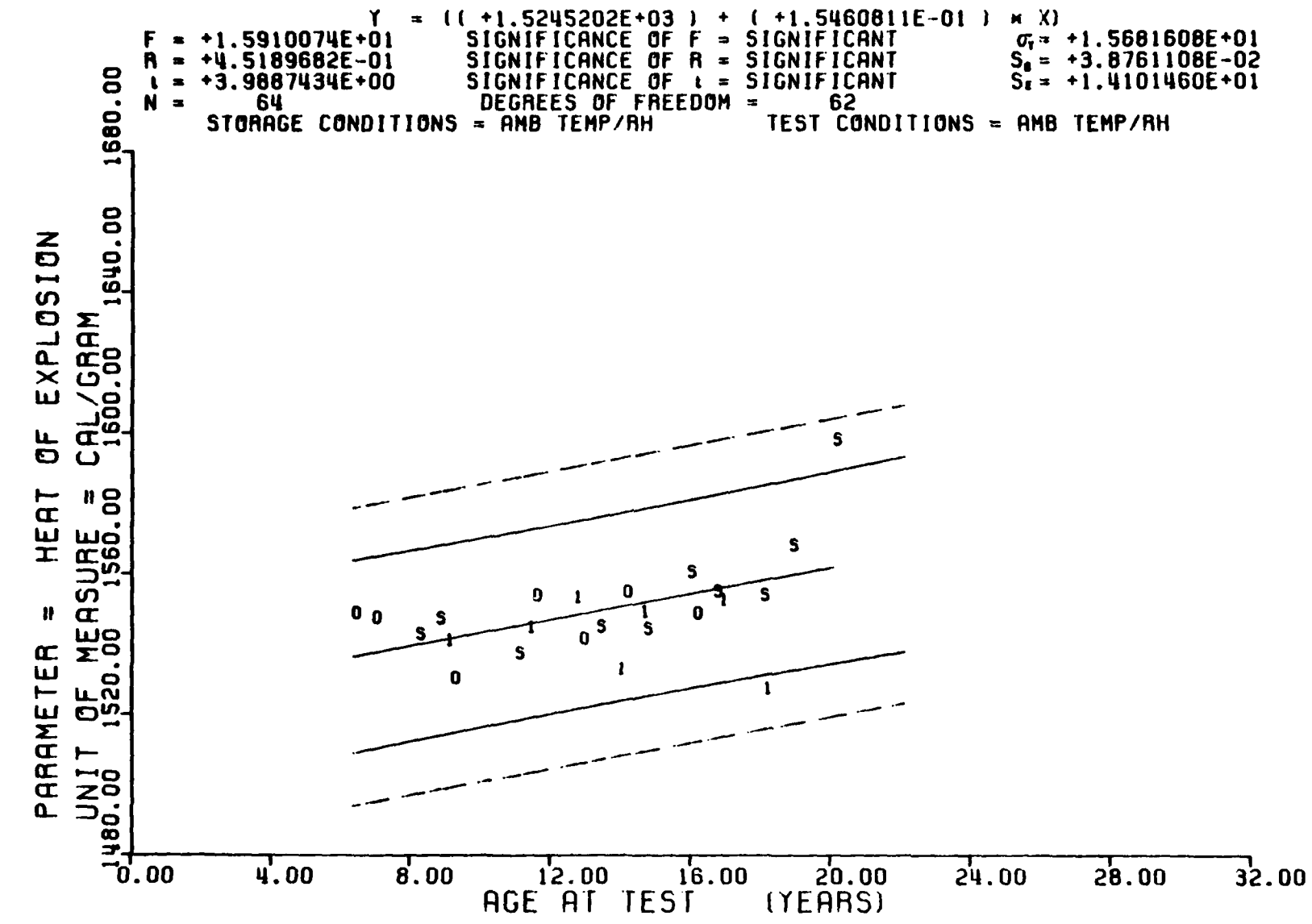
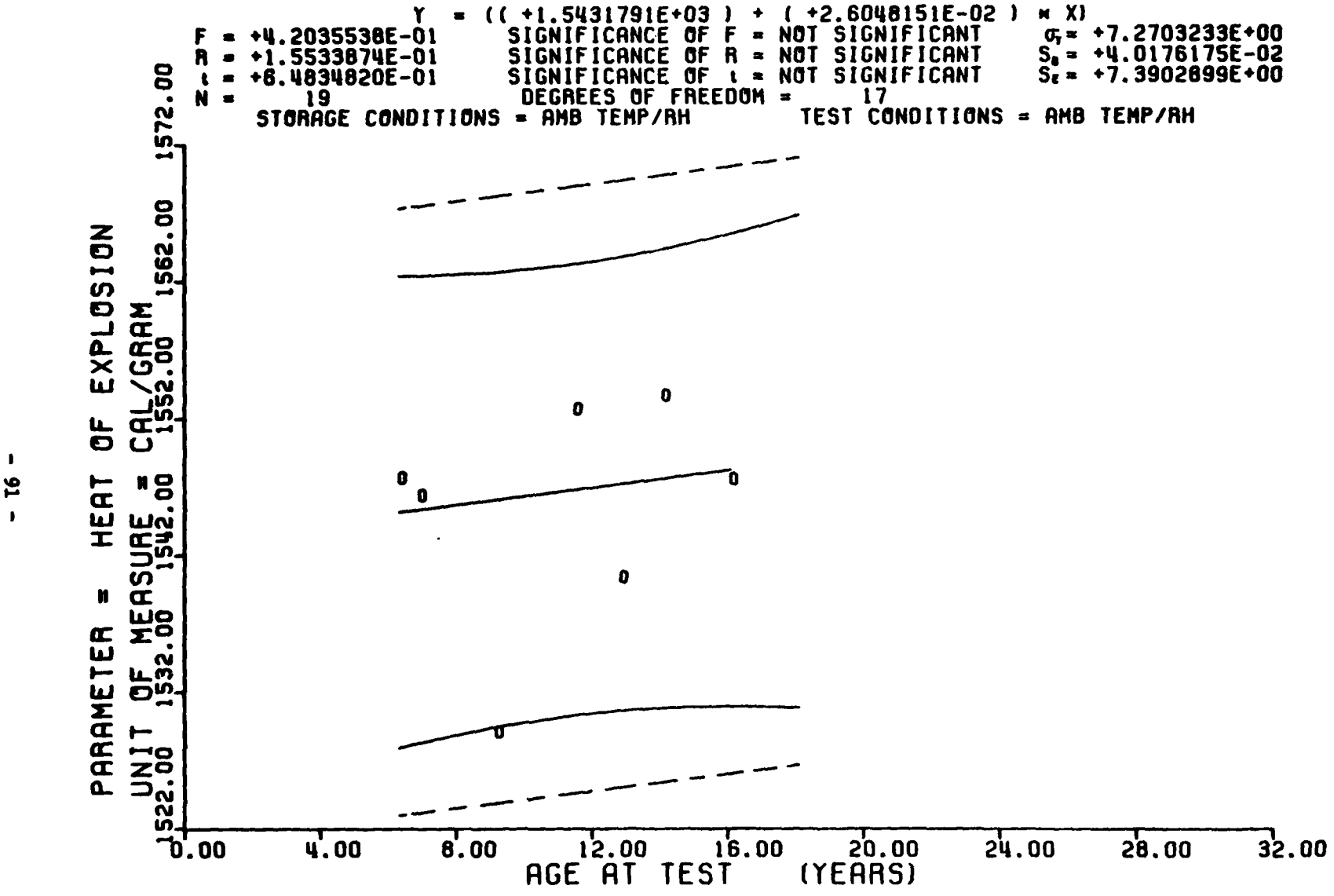

Y = ((+3.7591943E-01) + (-4.2446179E-04) * X)
F = +1.5864977E+02 SIGNIFICANCE OF F = SIGNIFICANT σr = +2.2235739E-02
R = -8.5032660E-01 SIGNIFICANCE OF R = SIGNIFICANT Sb = +3.3913586E-05
t = +1.2515980E+01 SIGNIFICANCE OF t = SIGNIFICANT St = +1.1798787E-02
N = 62 DEGREES OF FREEDOM = 60
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = BURNING RATE
UNIT OF MEASURE = INCHES/SEC
0.40
0.36
0.32
0.28
0.24
0.20
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1,DISSECTED MOTOR=(S)STM-012,BURNING RATE AT 1000 PSI INITIAL PRESSURE.

Figure 50-C



STAGE 1 DISSECTED MOTORS, HEAT OF EXPLOSION

Figure 51



STAGE 1, DISSECTED MOTOR=0012099, HEAT OF EXPLOSION

Figure 51-A

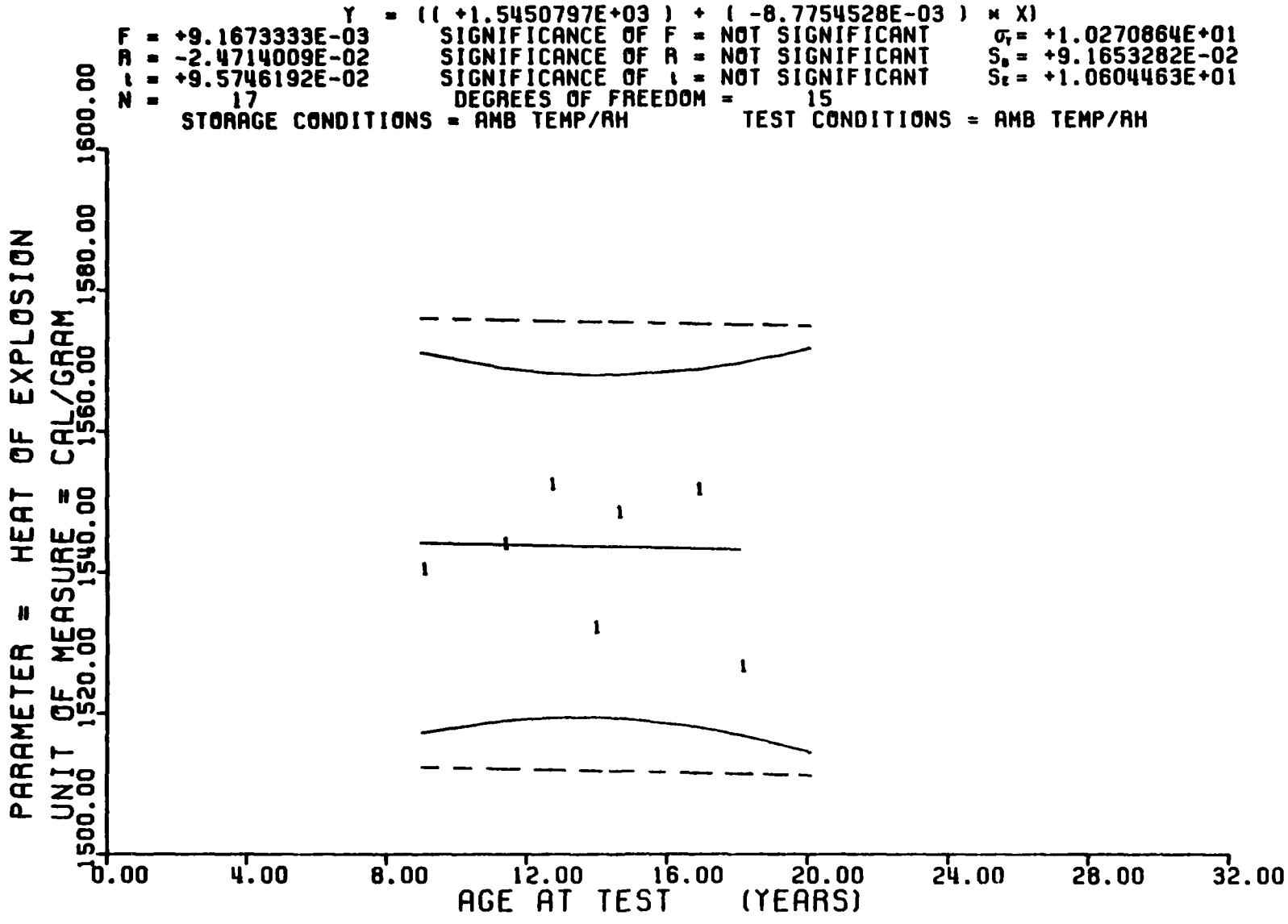
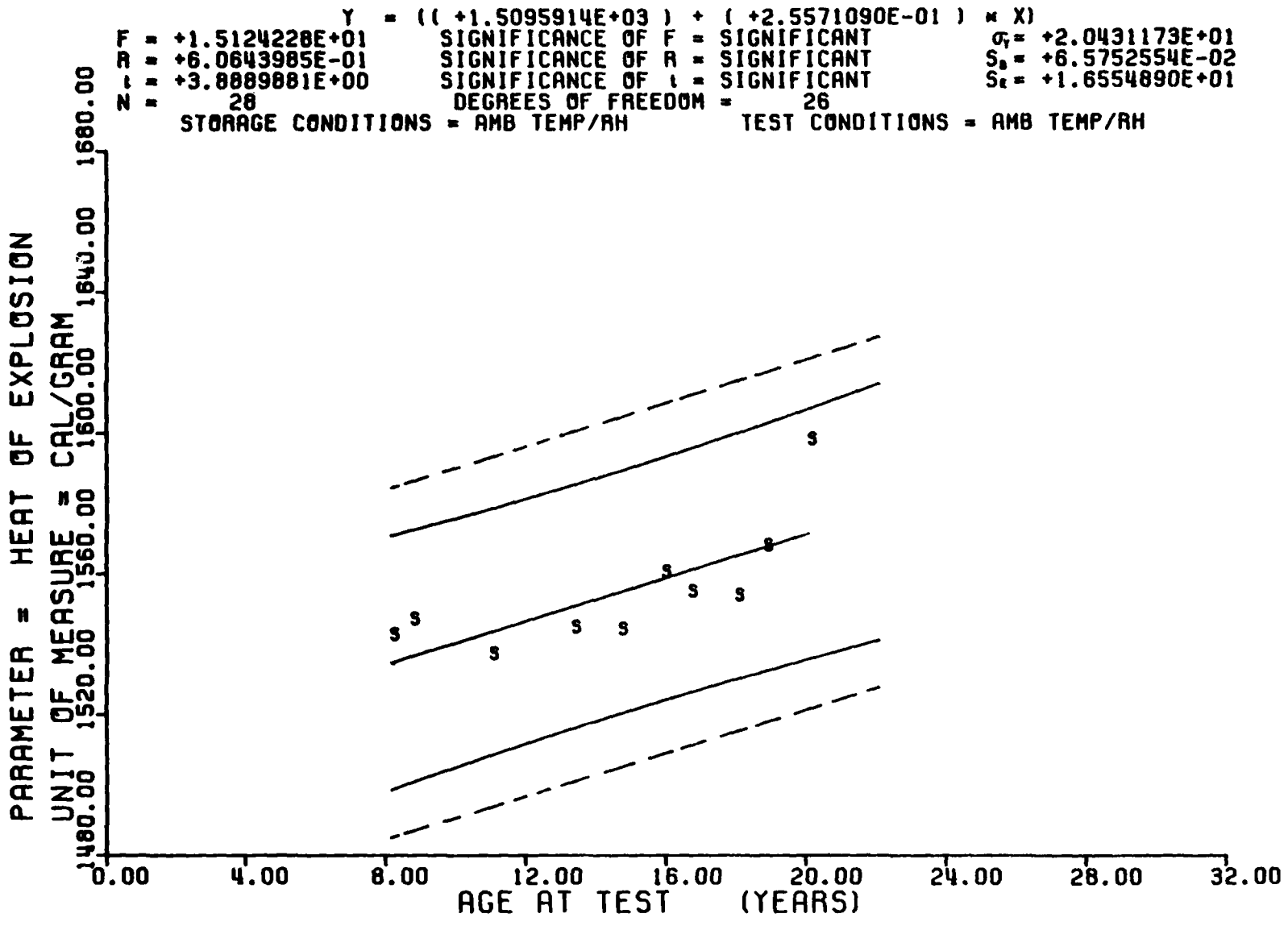

Y = ((+1.5450797E+03) + (-8.7754528E-03) x X)
F = +9.1673333E-03 SIGNIFICANCE OF F = NOT SIGNIFICANT σr = +1.0270864E+01
R = -2.4714009E-02 SIGNIFICANCE OF R = NOT SIGNIFICANT Sb = +9.1653282E-02
t = +9.5746192E-02 SIGNIFICANCE OF t = NOT SIGNIFICANT Se = +1.0604463E+01
N = 17 DEGREES OF FREEDOM = 15
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = HEAT OF EXPLOSION
UNIT OF MEASURE = CAL/GRAM
1600.00
1580.00
1560.00
1540.00
1520.00
1500.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1, DISSECTED MOTOR=0012199, HEAT OF EXPLOSION

Figure 51-B



STAGE 1, DISSECTED MOTOR-STM-012, HEAT OF EXPLOSION

Figure 51-C

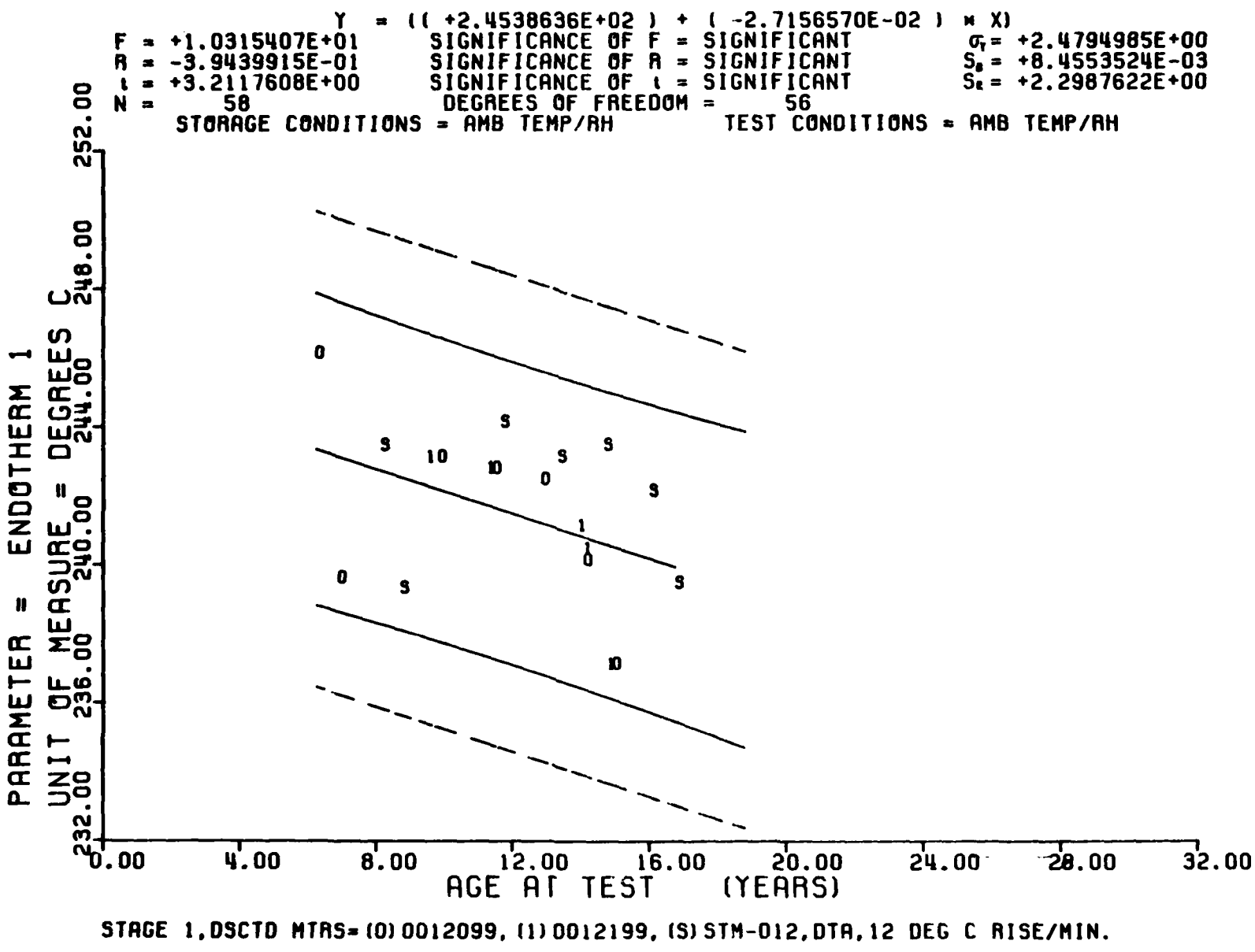

Y = ((+2.4538636E+02) + (-2.7156570E-02) * X)
F = +1.0315407E+01 SIGNIFICANCE OF F = SIGNIFICANT σT = +2.4794985E+00
R = -3.9439915E-01 SIGNIFICANCE OF R = SIGNIFICANT Se = +8.4553524E-03
t = +3.2117608E+00 SIGNIFICANCE OF t = SIGNIFICANT Sε = +2.2987622E+00
N = 58 DEGREES OF FREEDOM = 56
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = ENDOTHERM 1
UNIT OF MEASURE = DEGREES C
252.00
248.00
244.00
240.00
236.00
232.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1,DSCTD MTRS=(0)0012099, (1)0012199, (S)STM-012,DTA,12 DEG C RISE/MIN.

Figure 52

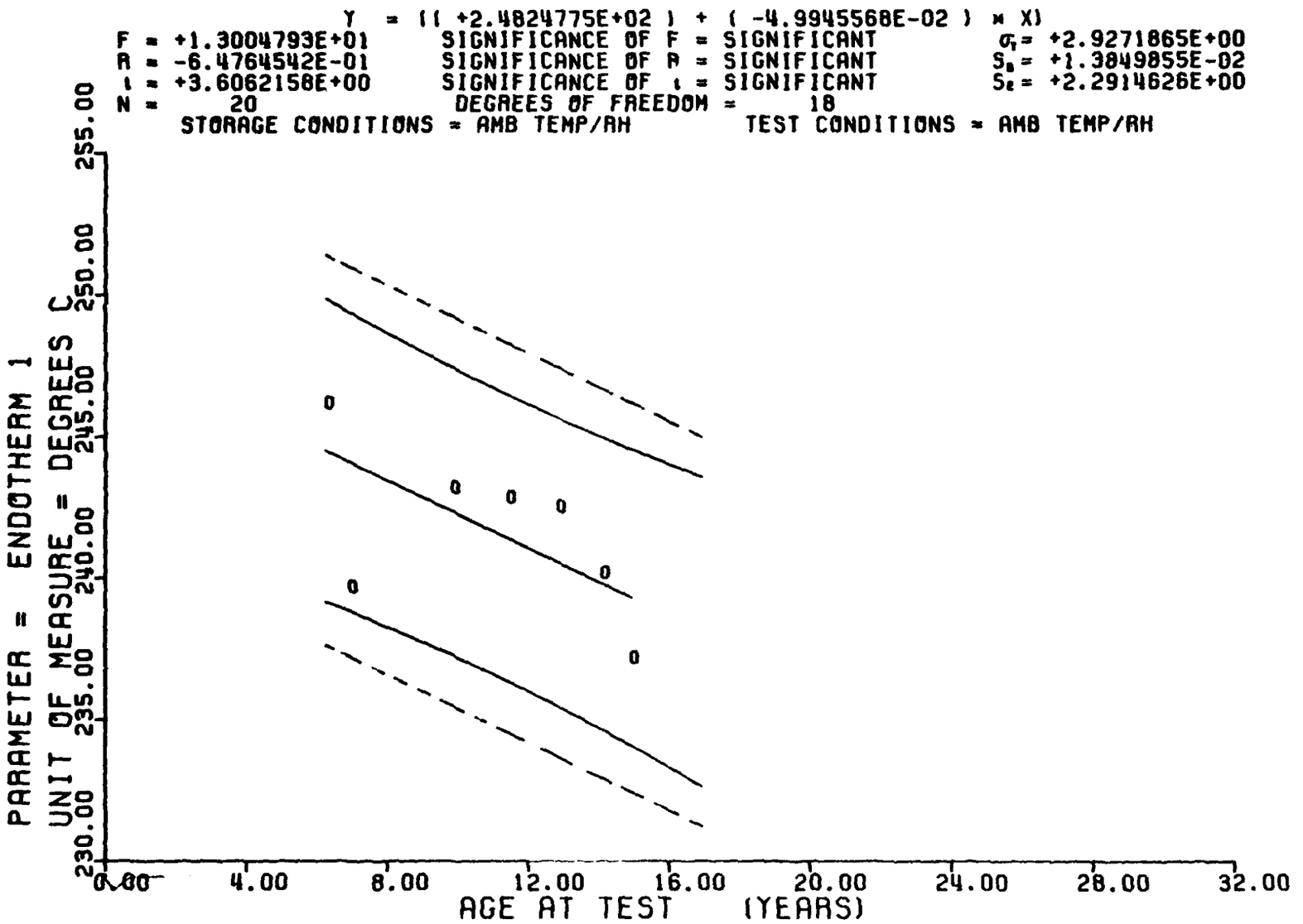
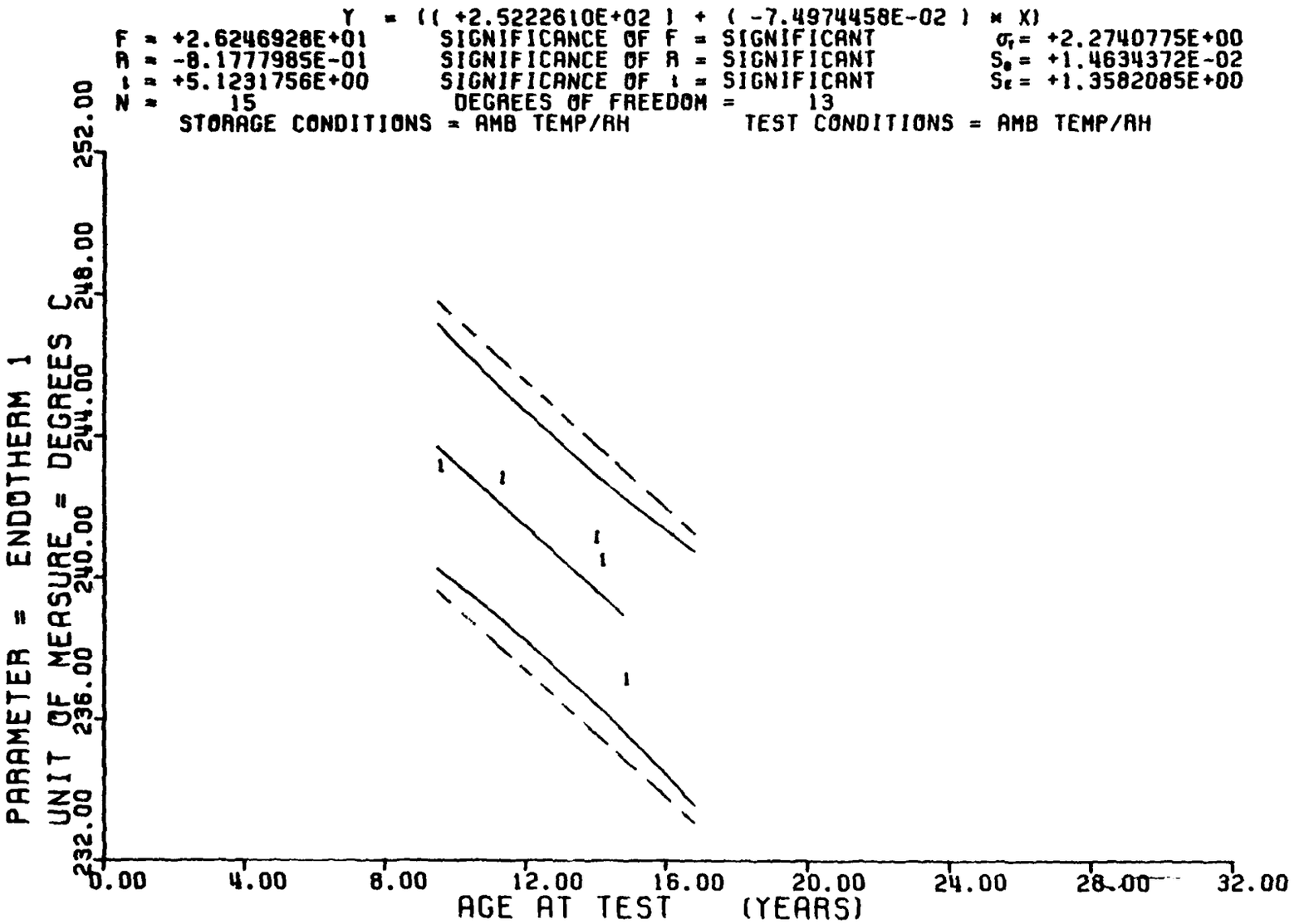

Y = ((+2.4824775E+02) + (-4.9945568E-02) * X)
F = +1.3004793E+01 SIGNIFICANCE OF F = SIGNIFICANT
R = -6.4764542E-01 SIGNIFICANCE OF R = SIGNIFICANT
t = +3.6062158E+00 SIGNIFICANCE OF t = SIGNIFICANT
N = 20 DEGREES OF FREEDOM = 18
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
σt = +2.9271865E+00
Sb = +1.3849855E-02
Se = +2.2914626E+00
PARAMETER = ENDOTHERM 1
UNIT OF MEASURE = DEGREES C
255.00
250.00
245.00
240.00
235.00
230.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1,DISSECTED MTR=(0)0012099,DTA,ENDOTHERM 1, 12 DEG C RISE/MIN.

Figure 52-A



STAGE 1,DISSECTED MTR=(1)0012199,DTA,ENDOTHERM 1, 12 DEG C RISE/MIN.

Figure 52-B

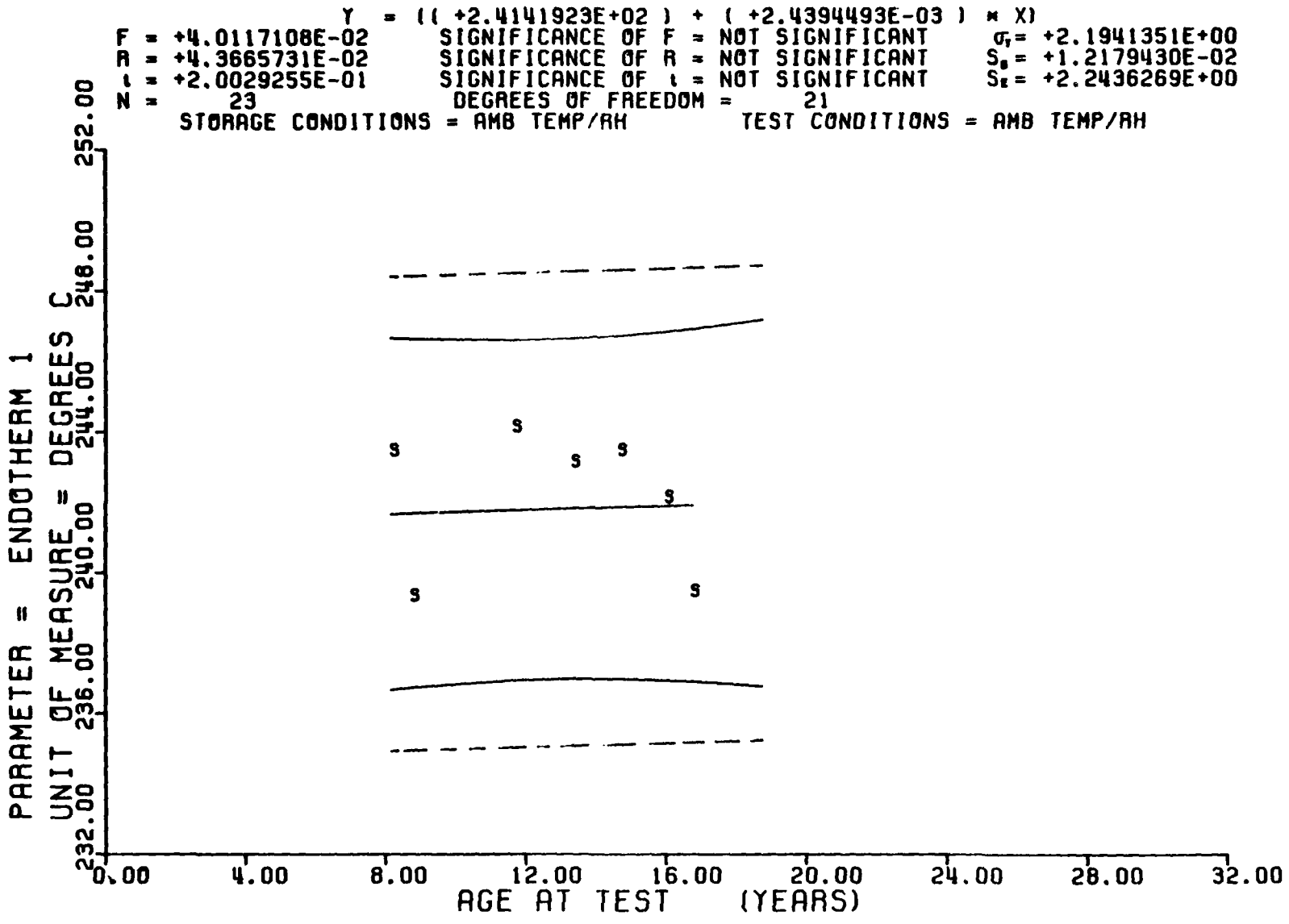

Y = ((+2.4141923E+02) + (+2.4394493E-03) * X)
F = +4.0117108E-02 SIGNIFICANCE OF F = NOT SIGNIFICANT σ_Y = +2.1941351E+00
R = +4.3665731E-02 SIGNIFICANCE OF R = NOT SIGNIFICANT S_e = +1.2179430E-02
t = +2.0029255E-01 SIGNIFICANCE OF t = NOT SIGNIFICANT S_t = +2.2436269E+00
N = 23 DEGREES OF FREEDOM = 21
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = ENDOTHERM 1
UNIT OF MEASURE = DEGREES C
252.00
248.00
244.00
240.00
236.00
232.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1,DISSECTED MTR=(S)STM-012,DTA,ENDOTHERM 1, 12 DEG C RISE/MIN.

Figure 52-C

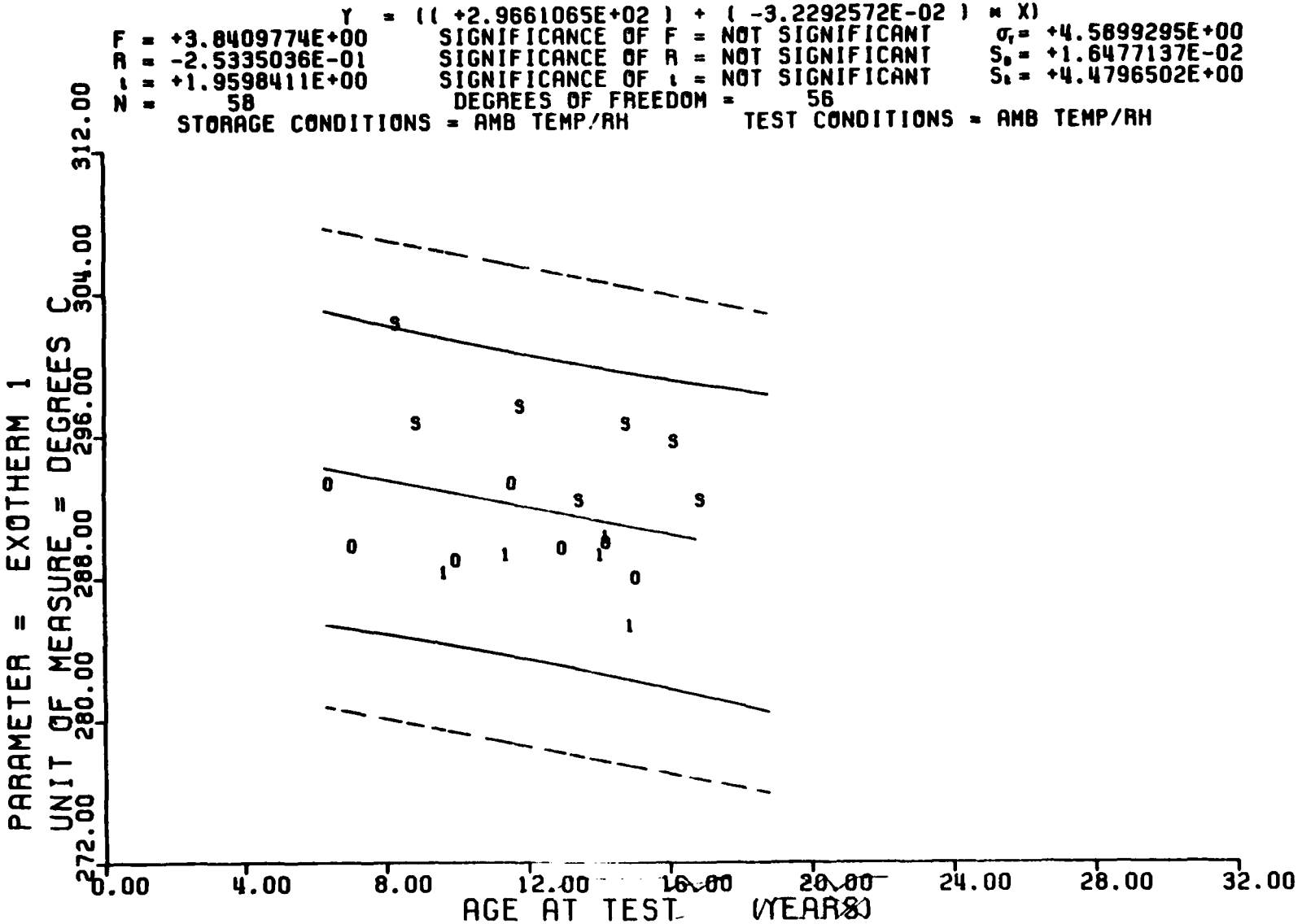

Y = ((+2.9661065E+02) + (-3.2292572E-02) * X)
F = +3.8409774E+00 SIGNIFICANCE OF F = NOT SIGNIFICANT σr = +4.5899295E+00
R = -2.5335036E-01 SIGNIFICANCE OF R = NOT SIGNIFICANT Sb = +1.6477137E-02
t = +1.9598411E+00 SIGNIFICANCE OF t = NOT SIGNIFICANT St = +4.4796502E+00
N = 58 DEGREES OF FREEDOM = 56
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = EXOTHERM 1
UNIT OF MEASURE = DEGREES C
312.00
304.00
296.00
288.00
280.00
272.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1,OSCTO MTRS=(0)0012099, (1)0012199, (S)STM-012,0TA,12 DEG C RISE/MIN.

Figure 53

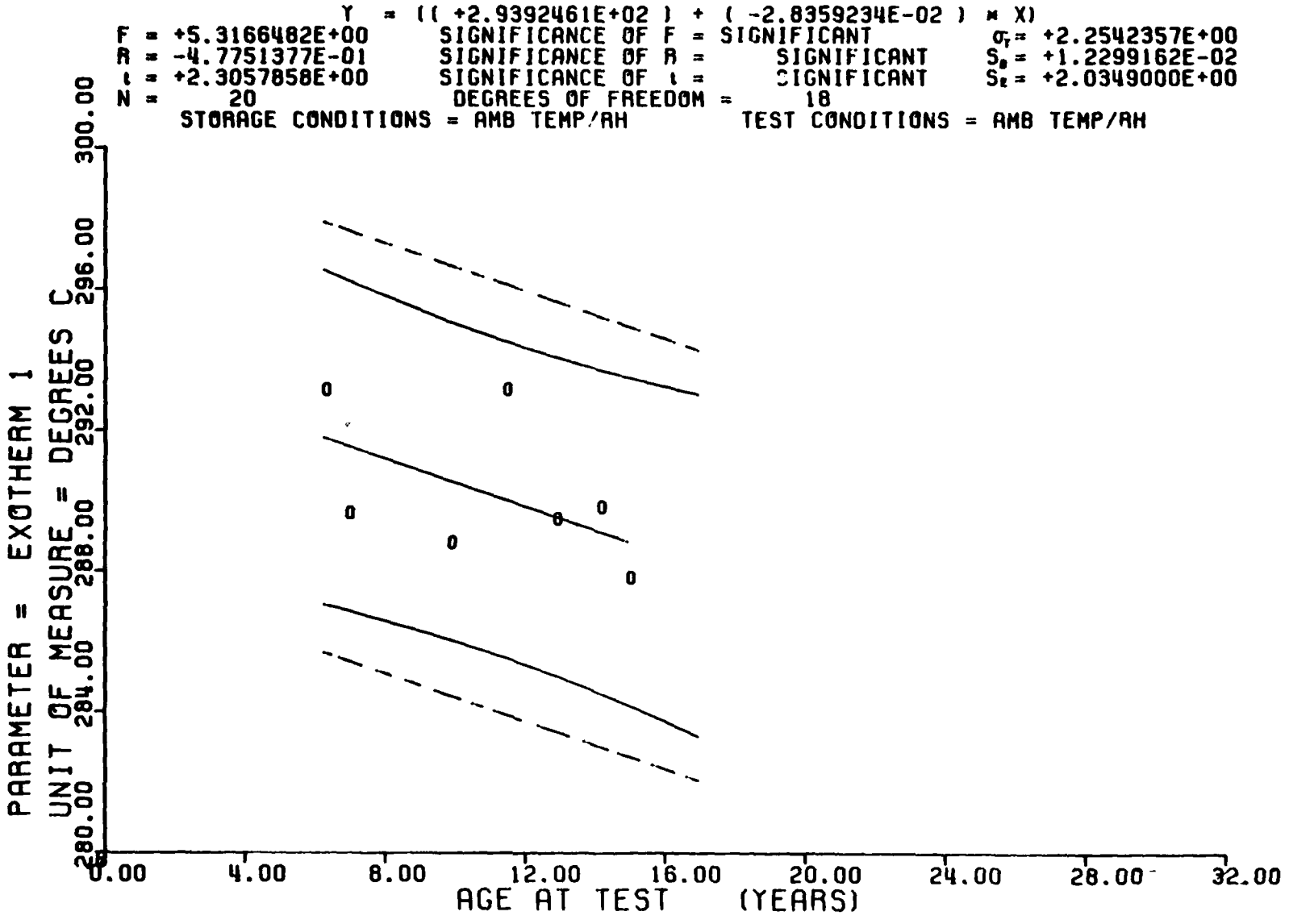

Y = ((+2.9392461E+02) + (-2.8359234E-02) * X)
F = +5.3166482E+00 SIGNIFICANCE OF F = SIGNIFICANT σT = +2.2542357E+00
R = -4.7751377E-01 SIGNIFICANCE OF R = SIGNIFICANT Sb = +1.2299162E-02
t = +2.3057858E+00 SIGNIFICANCE OF t = SIGNIFICANT Se = +2.0349000E+00
N = 20 DEGREES OF FREEDOM = 18
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = EXOTHERM 1
UNIT OF MEASURE = DEGREES C
300.00
296.00
292.00
288.00
284.00
280.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1,DISSECTED MTR=(0)0012099,DTA,EXOTHERM 1, 12 DEG C RISE/MIN.

Figure 53-A

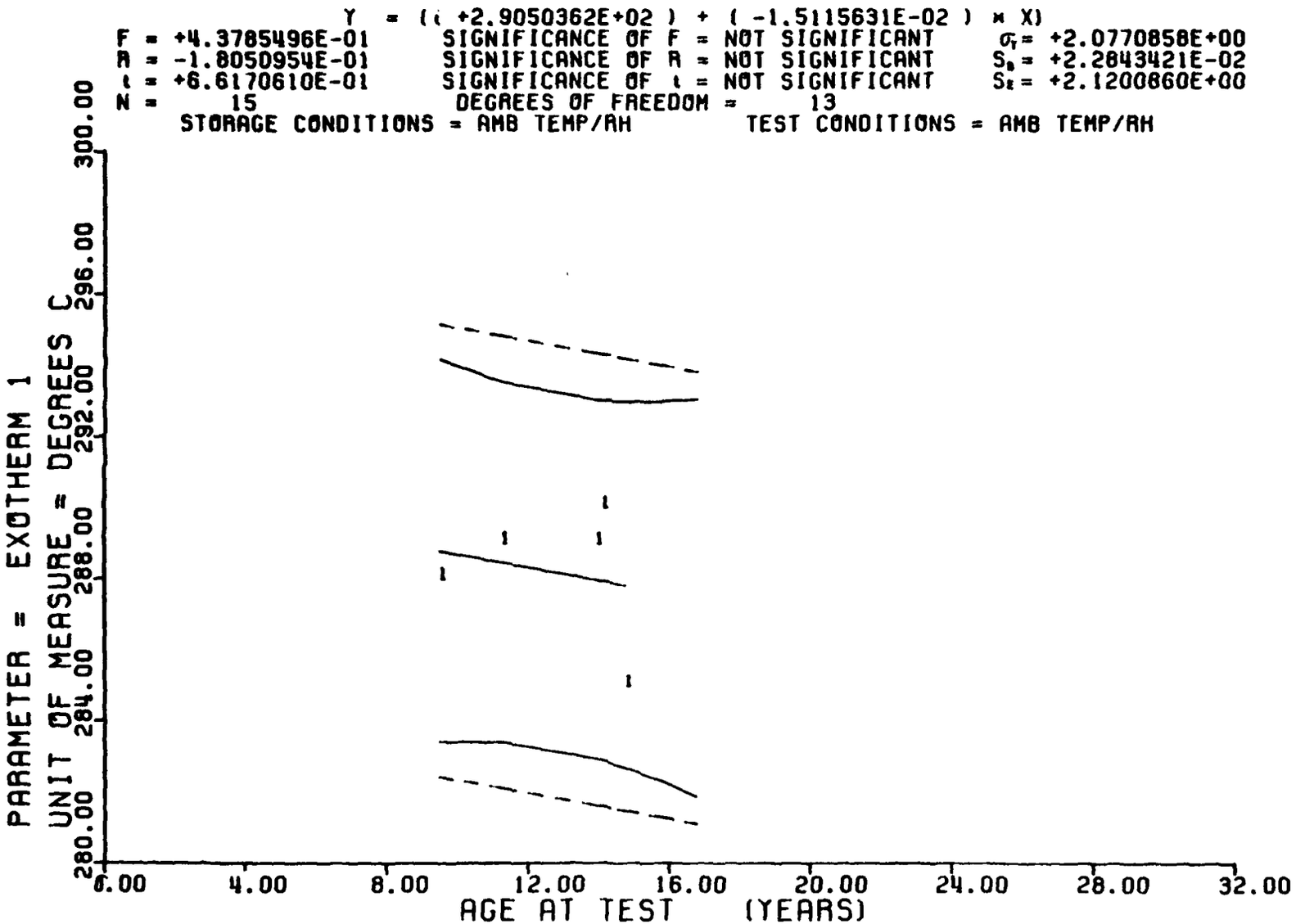

Y = (+2.9050362E+02) + (-1.5115631E-02) * X)
F = +4.3785496E-01 SIGNIFICANCE OF F = NOT SIGNIFICANT σr = +2.0770858E+00
R = -1.8050954E-01 SIGNIFICANCE OF R = NOT SIGNIFICANT Sb = +2.2843421E-02
t = +6.6170610E-01 SIGNIFICANCE OF t = NOT SIGNIFICANT Se = +2.1200860E+00
N = 15 DEGREES OF FREEDOM = 13
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = EXOTHERM 1
UNIT OF MEASURE = DEGREES C
300.00
296.00
292.00
288.00
284.00
280.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1,DISSECTED MTR=(1)0012199,DTA,EXOTHERM 1, 12 DEG C RISE/MIN.

Figure 53-B

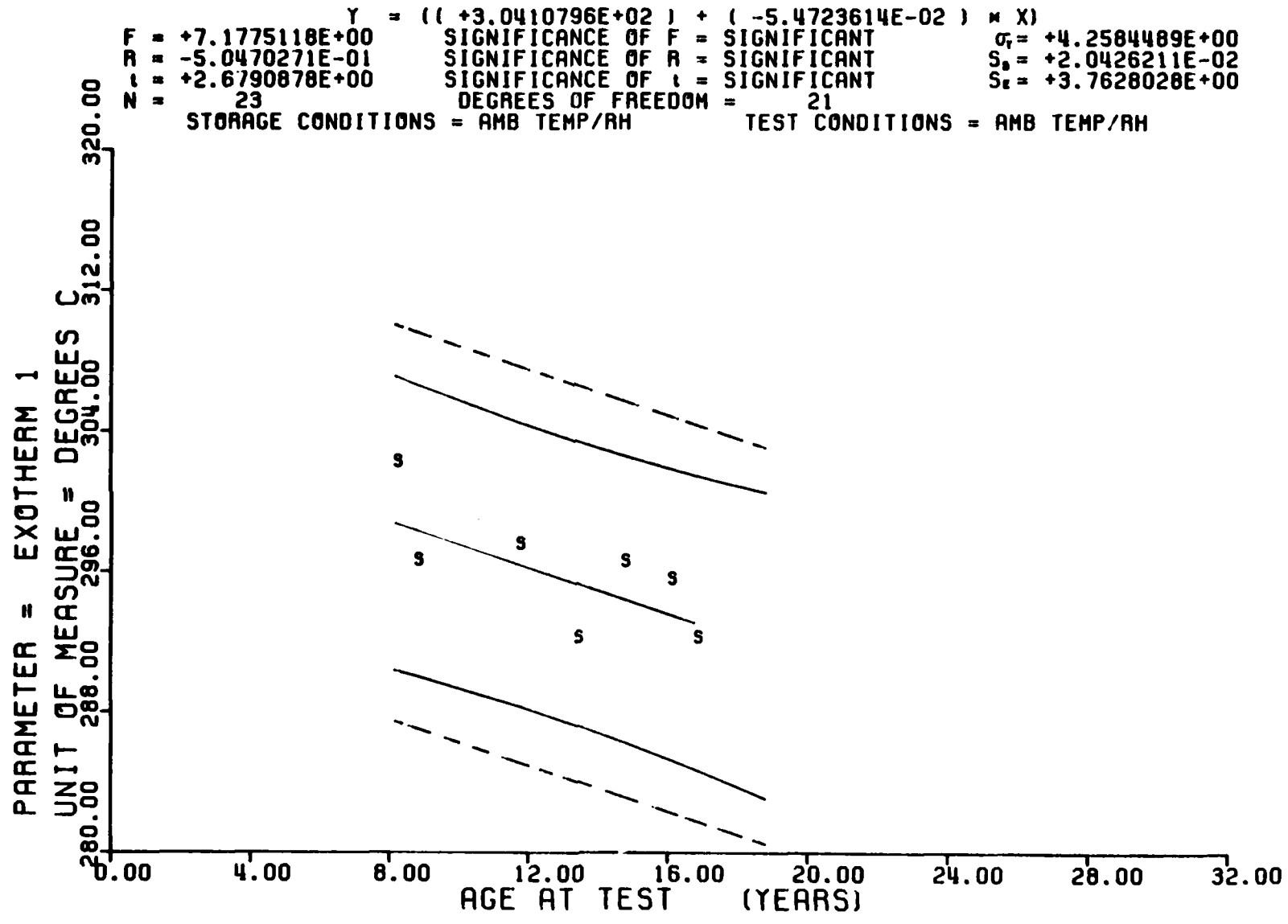

Y = ((+3.0410796E+02) + (-5.4723614E-02) * X)
F = +7.1775118E+00 SIGNIFICANCE OF F = SIGNIFICANT σr = +4.2584489E+00
R = -5.0470271E-01 SIGNIFICANCE OF R = SIGNIFICANT Sb = +2.0426211E-02
t = +2.6790878E+00 SIGNIFICANCE OF t = SIGNIFICANT Se = +3.7628028E+00
N = 23 DEGREES OF FREEDOM = 21
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = EXOTHERM 1
UNIT OF MEASURE = DEGREES C
320.00
312.00
304.00
296.00
288.00
280.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
S
STAGE 1,DISSECTED MTR=(S)STM-012,DTA,EXOTHERM 1, 12 DEG C RISE/MIN.

Figure 53-C

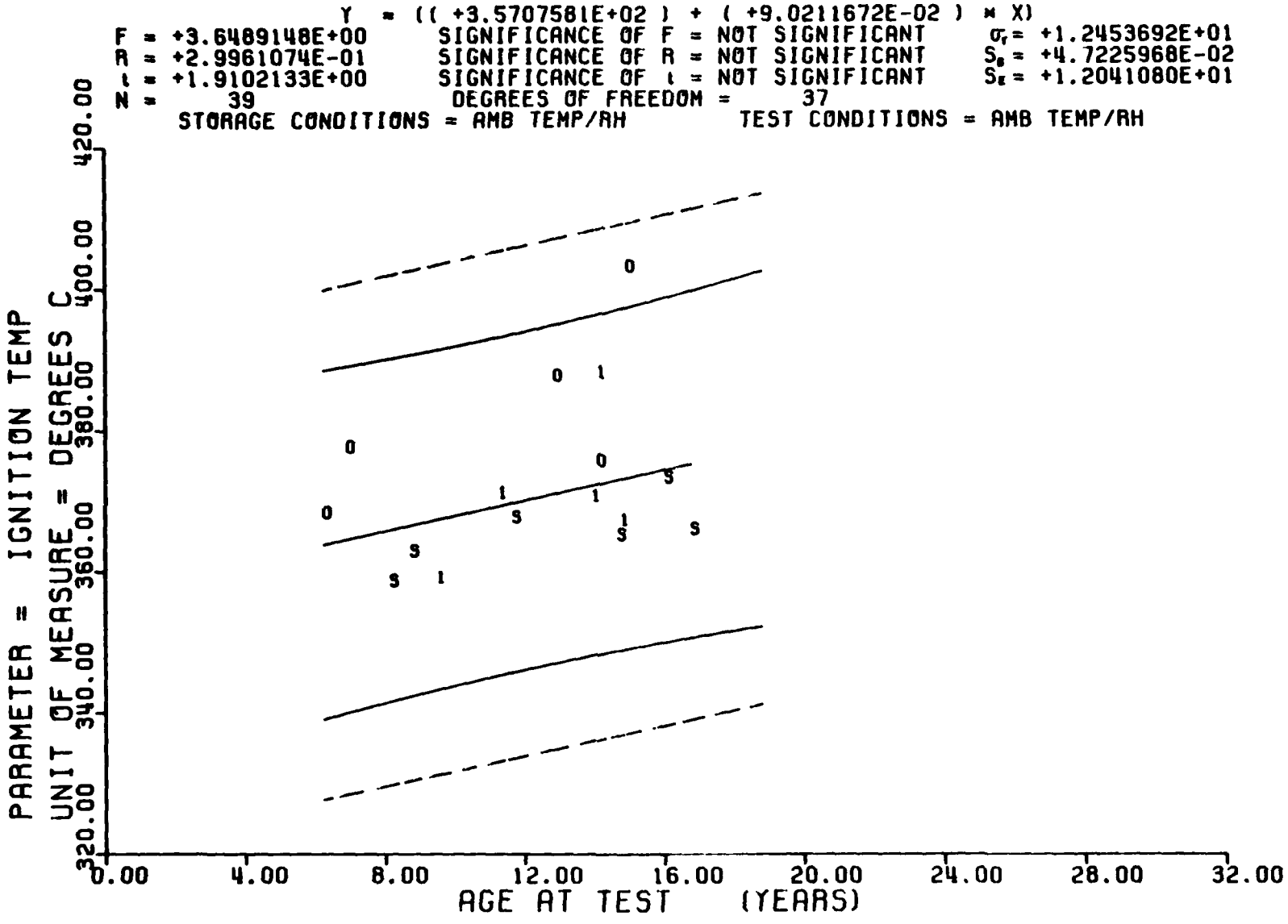

Y = ((+3.5707581E+02) + (+9.0211672E-02) * X)
F = +3.6489148E+00 SIGNIFICANCE OF F = NOT SIGNIFICANT σr = +1.2453692E+01
R = +2.9961074E-01 SIGNIFICANCE OF R = NOT SIGNIFICANT Se = +4.7225968E-02
t = +1.9102133E+00 SIGNIFICANCE OF t = NOT SIGNIFICANT St = +1.2041080E+01
N = 39 DEGREES OF FREEDOM = 37
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = IGNITION TEMP
UNIT OF MEASURE = DEGREES C
320.00
340.00
360.00
380.00
400.00
420.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1, DSCTO MTRS= (0) 0012099, (1) 0012199, (S) STM-012, DTA, 12 DEG C RISE/MIN.

Figure 54

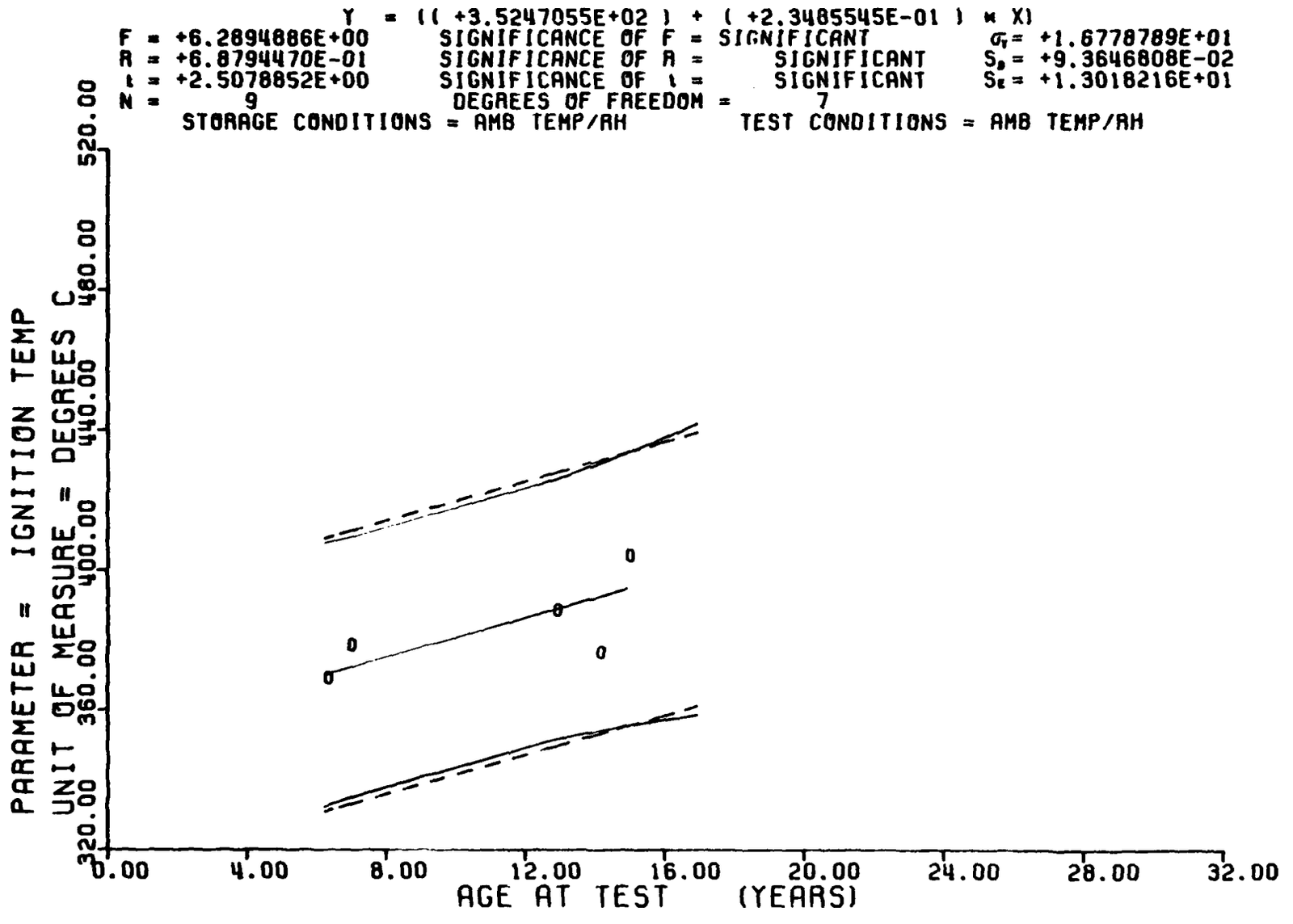

Y = ((+3.5247055E+02) + (+2.3485545E-01) * X)
F = +6.2894886E+00 SIGNIFICANCE OF F = SIGNIFICANT σ_Y = +1.6778789E+01
R = +6.8794470E-01 SIGNIFICANCE OF R = SIGNIFICANT S_B = +9.3646808E-02
t = +2.5078852E+00 SIGNIFICANCE OF t = SIGNIFICANT S_E = +1.3018216E+01
N = 9 DEGREES OF FREEDOM = 7
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = IGNITION TEMP
UNIT OF MEASURE = DEGREES C
320.00
360.00
400.00
440.00
480.00
520.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1,DISSECTED MTR=(0)0012099,DTA,IGNITION TEMP,12 DEG C RISE/MIN.

Figure 54-A

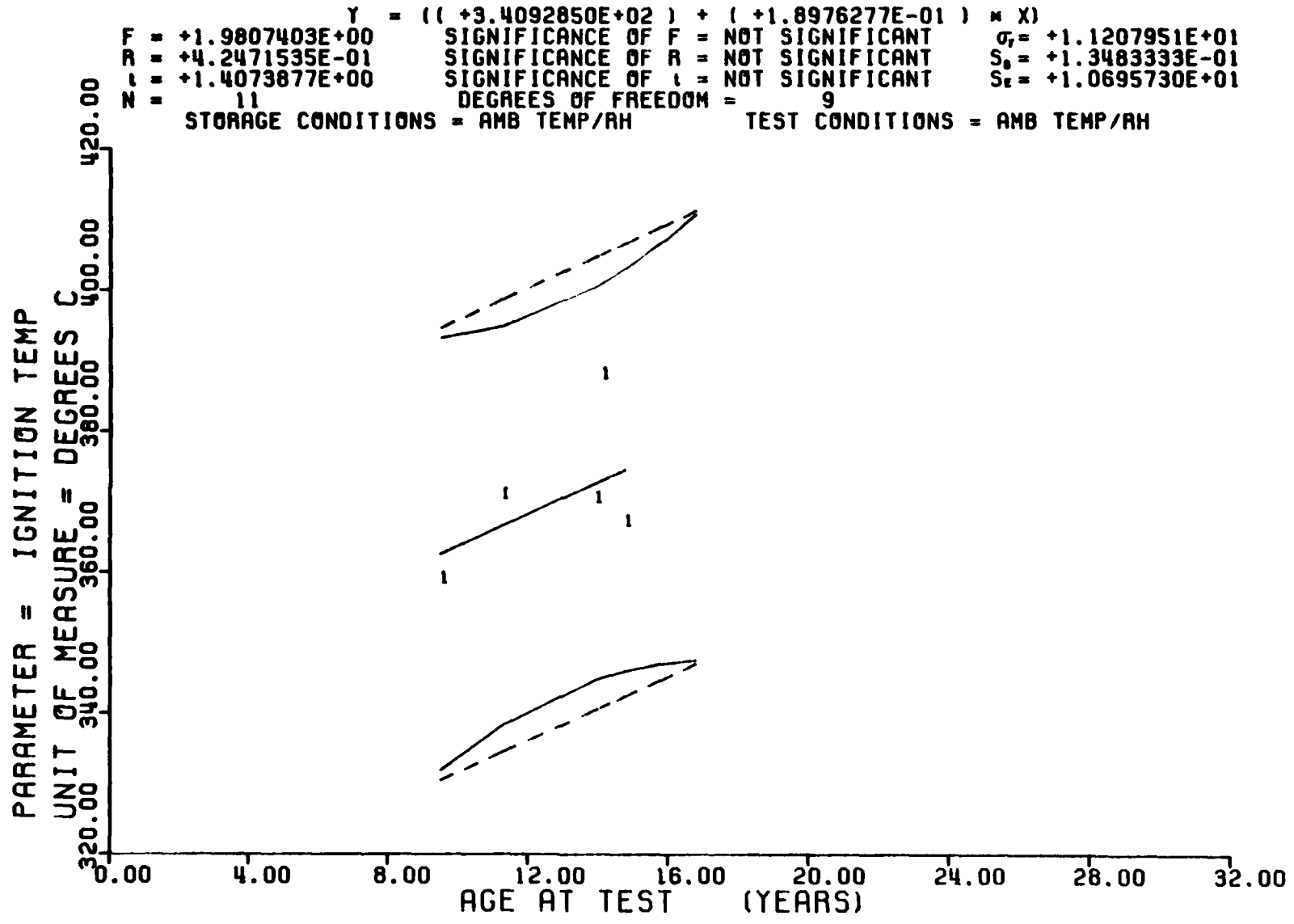
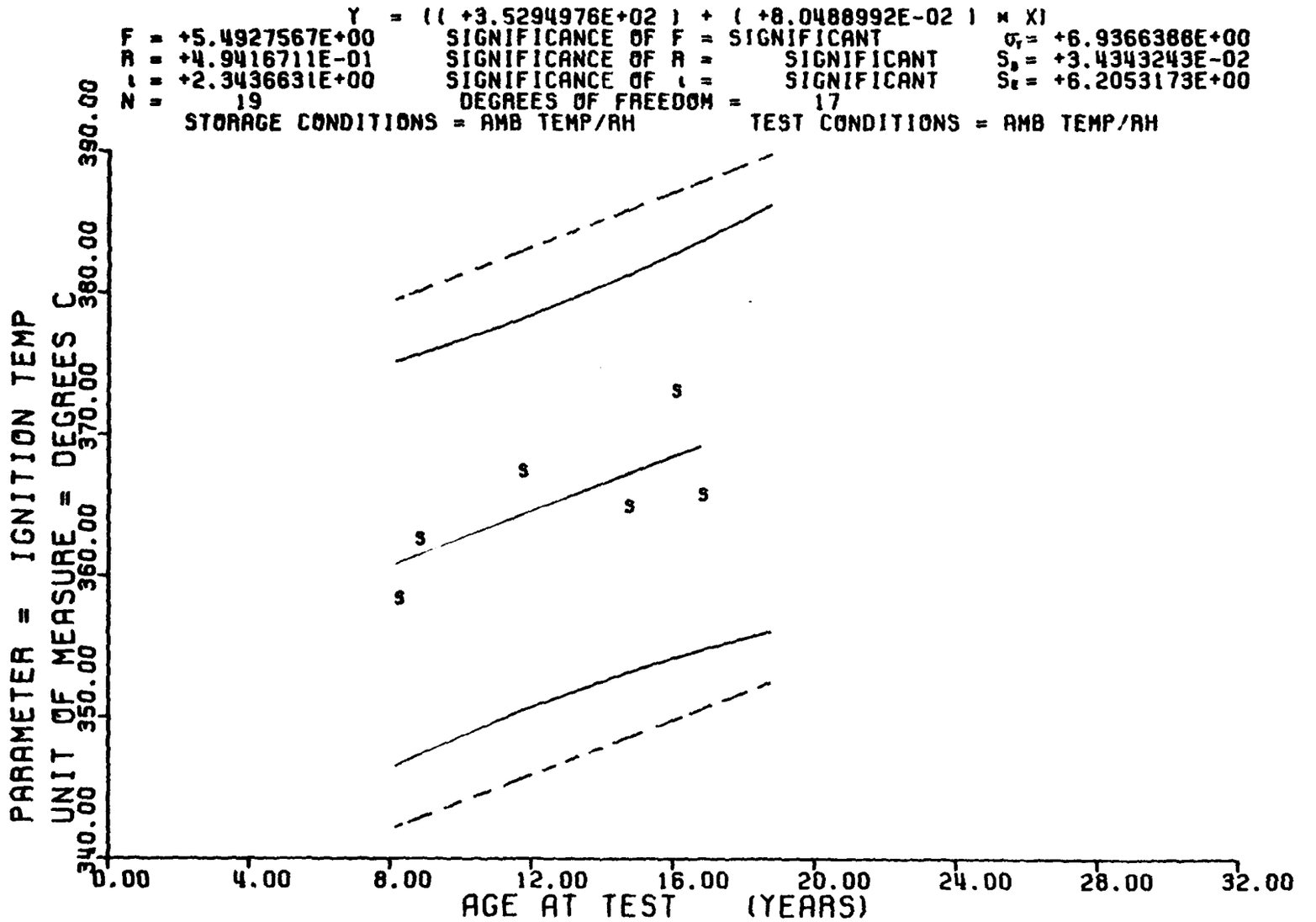

Y = ((+3.4092850E+02) + (+1.8976277E-01) * X)
F = +1.9807403E+00 SIGNIFICANCE OF F = NOT SIGNIFICANT σr = +1.1207951E+01
R = +4.2471535E-01 SIGNIFICANCE OF R = NOT SIGNIFICANT Se = +1.3483333E-01
t = +1.4073877E+00 SIGNIFICANCE OF t = NOT SIGNIFICANT Sε = +1.0695730E+01
N = 11 DEGREES OF FREEDOM = 9
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = IGNITION TEMP
UNIT OF MEASURE = DEGREES C
320.00
340.00
360.00
380.00
400.00
420.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1,DISSECTED MTR=(1)0012199,DTA,IGNITION TEMP,12 DEG C RISE/MIN.

Figure 54-B



STAGE 1, DISSECTED MTR= (S) STM-012, DTA, IGNITION TEMP, 12 DEG C RISE/MIN.

Figure 54-C

DISTRIBUTION

	NR COPIES
OOALC	
MMWRBM	1
MMWRAM	1
DDC (TISIR) Cameron Station, Alexandria, VA 22314	2
SAMSO, Norton AFB, CA 92409 Attn: Mr. Sanford Collins, Bldg. 562, Room 613	1
AFPRO, Thiokol Chemical Corporation Wasatch Division P.O. Box 524 Brigham City, UT 84302 (Cy to Larry Hales)	2
AFRPL (MKPB) Edwards AFB, CA 93523	1
SAC (LGBM) Offutt AFB, NB 68113	1
U. S. Naval Ordnance Station, Indian Head, MD 20460 M. E. Loman, Code 3012A4 Air Launched Weapons Branch Weapons Quality Engineering Center	1
CPIA, Johns Hopkins University Applied Physics Lab John Hopkins Road, Laurel, MD 20810 Attn: Mr. Ronald D. Brown	1
Naval Plant Branch Representative Attn: Mr. David W. Pratt P. O. Box 157, Bacchus Works Magna, UT 84044	1

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER MANPA Report Nr. 470(82)	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Surveillance Report, Stage I Dissected Motors, Phase XIII		5. TYPE OF REPORT & PERIOD COVERED Test Results - Semi Annual 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) JOHN A. THOMPSON		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Propellant Analysis Laboratory Directorate of Maintenance Hill AFB, UT 84056		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Service Engineering Division Directorate of Materiel Management Hill AFB, UT 84056		12. REPORT DATE May 1982 13. NUMBER OF PAGES 117
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/ DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for Public Release, Distribution Unlimited		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Minuteman Solid Propellant		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Testing was performed to determine the useful shelf/service life for LGM-30 Stage I Rocket Motors. A three year storage program for propellant and components was started in May 1961. This program was then extended to a ten year study and later continued indefinitely to assure that a deterioration in motor physical characteristics could be detected in time to take some corrective actions before the weapon system performance deteriorated below an acceptable level.		

DD FORM 1 JAN 73 1473

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

This report covers only propellant data and limited case bond data. The malfunction of an environmental chamber destroyed component samples that had originally been part of this testing program (and the inadvertent burning of some motors during dissection reduced the material available for testing). Planned dissection of selected motors in the future will provide samples for continued component testing. Test specimens for this reporting period were obtained from motors STM-012, 0012099, and 0012199. UP-7775 block propellant was not tested since that propellant has been used up.

A new technique of Multi-symbol Regression Analysis was used to determine aging trends. Also, using a unique plotting code for each motor tested demonstrates the relationship between motors and block propellant. The plotting symbols for each motor and block propellant are listed in the statistical analyses section.

The data from this test period was combined with data from previous testing and entered into the G085 computer for storage, analysis, and regression analysis. From the statistical analysis of all data tested to date, significant degradation of the propellant does not appear likely for at least two years past the oldest data point.

Future testing will be conducted on dissected motors.

EN

DA
FIL

08

DT